Devoted to
TEXTILE
CHEMISTRY
BLEACHING
DYEING
PRINTING
FINISHING

JANUARY 12, 1948
VOLUME 37, No. 1

AMERICAN DYESTUFF REPORTER

JAN 19
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A label without a label

Sounds like a silly statement—but it isn't . . .

for even more prominent than any merchandising label is the distinction between the *whiteness* of a cellulosic fabric, on which *Tinopal B V A* has been applied and one processed by ordinary means. Putting the two pieces side by side on the counter, the untreated piece will look greyish in comparison, and for good reasons. First and foremost is the fact that Tinopal B V A produces *whiter whites* than ever before were possible. Second, Tinopal B V A does not add coloring matter but rather imparts practically an indiscernible fluorescence which increases reflected light.

Yes, *Tinopalized* goods carries its own label—and you can't mistake it.

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NEW YORK—NEW YORK
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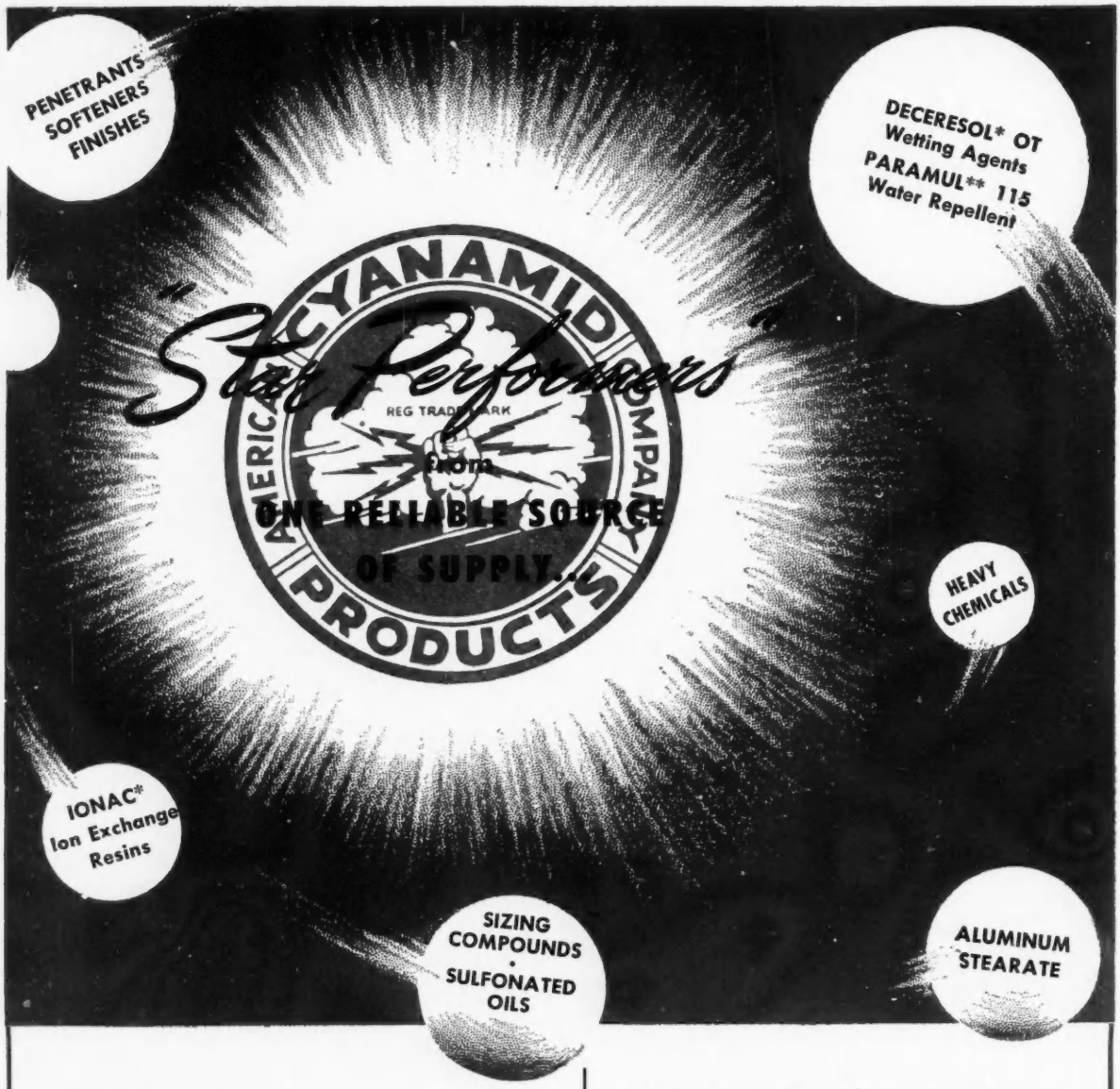
The Geigy Co., Ltd.
National Buildings
Parsonage, Manchester

OFFICIAL PUBLICATION
of the
PROCEEDINGS
AMERICAN ASSOCIATION
OF TEXTILE-CHEMISTS
AND COLORISTS



IN SUPPLY...

You can look to Cyanamid for a wide range of high-quality staple and special chemicals that will help make your textiles "star performers" in quality, too.

IN RESEARCH...

Cyanamid's active research department is continuing to develop new specialties that will help make your textiles still more attractive, durable, and salable.

IN TECHNICAL SERVICE...

Our expert technical staff, widely experienced in textile chemistry and its practical application, is ready at all times to help you work out your problems, through application of Cyanamid materials.

Industrial AMERICAN
Chemicals CYANAMID
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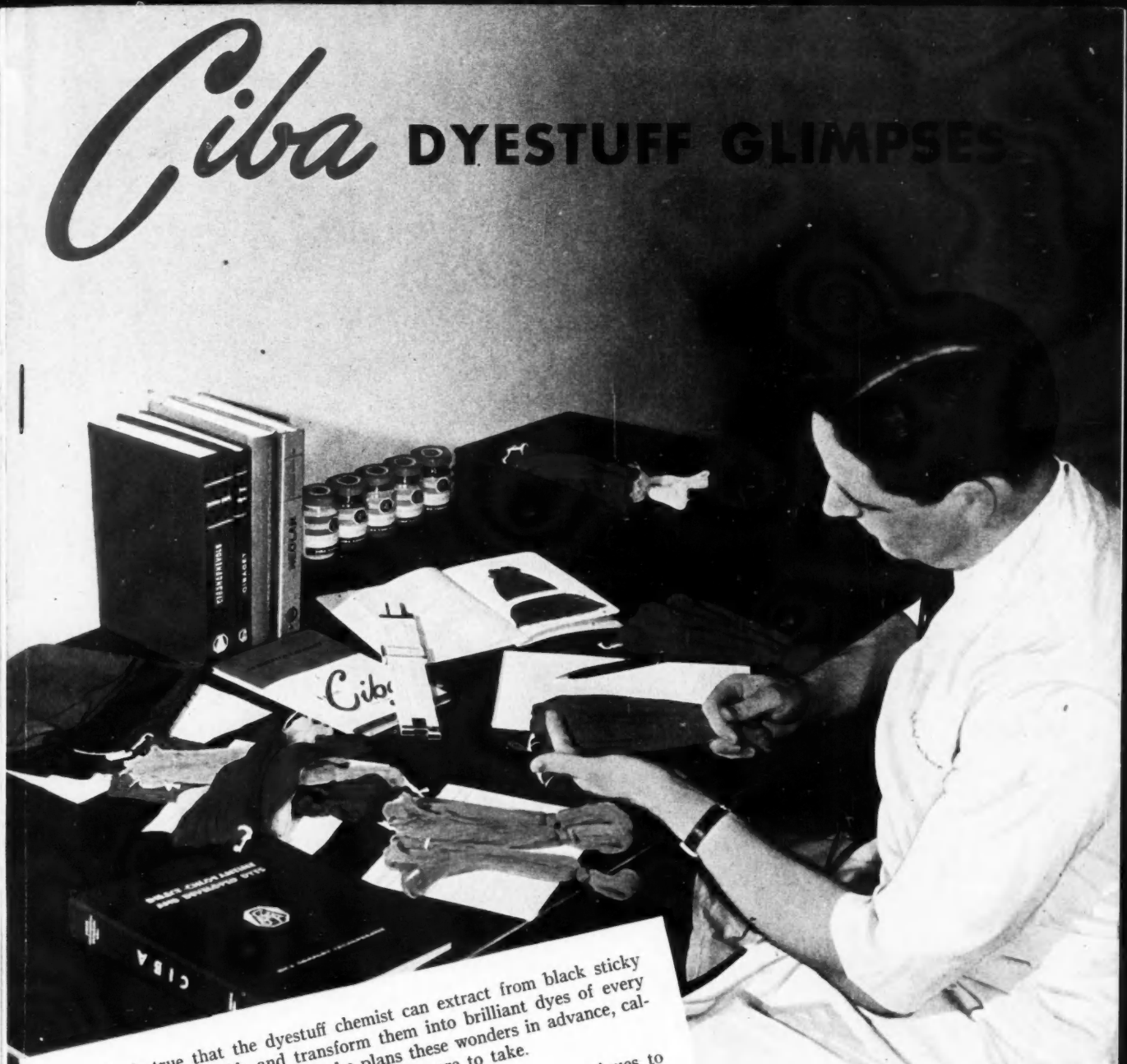
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

AMONG CYANAMID PRODUCTS FOR THE TEXTILE INDUSTRY ARE... AQUASOL* Sulfonated Castor Oils; NO-ODOROL* Finishing Oils; DECERESOL* OT Wetting Agents; PARAMUL** 115 Water Repellent; Penetrants, Softeners, Finishes, Sizing Compounds, and other specialties and Heavy Chemicals. For low-cost chemical equivalent of distilled H_2O... FILT-R-STIL* Demineralizing Units.

*Reg. U. S. Pat. Off. **Trade-mark

American Dyestuff Reporter, Vol. 37, No. 1, January 12, 1948. Published every other Monday. Copyright, 1948, by Howes Publishing Co., One Madison Ave., New York 10, N. Y. Domestic subscription, $5.00; Canadian, $6.00; Foreign, $10.00. Entered as second-class matter, Nov. 6, 1919, at the New York, N. Y., Post Office, under the act of March 3, 1879.

Ciba DYESTUFF GLIMPSES



It is true that the dyestuff chemist can extract from black sticky tar crystal clear liquids and transform them into brilliant dyes of every shade imaginable. More amazing, he plans these wonders in advance, calculates them and determines the course they are to take.

Nature, however, reveals her secrets reluctantly and continues to present ever new riddles in the miracle of color. For a time the molecules seem to be guided willingly along the road mapped out for them — then suddenly they strike out on their own, like an army in revolt against the strategy of its leader. Or maybe the chemist will succeed, after months or years of effort synthesizing a new dyestuff, only to find that it is not equal to his expectations. The daily work of the industrial laboratories of the world is enormous but on the average, out of several hundreds of dyestuffs prepared, only one marks a decisive improvement over those already on the market.

Step by step generations of chemists have raised Ciba's range of dyestuffs to its present eminence. For every consumer and every purpose it offers dyestuffs which yield shades of unexcelled beauty and fastness.

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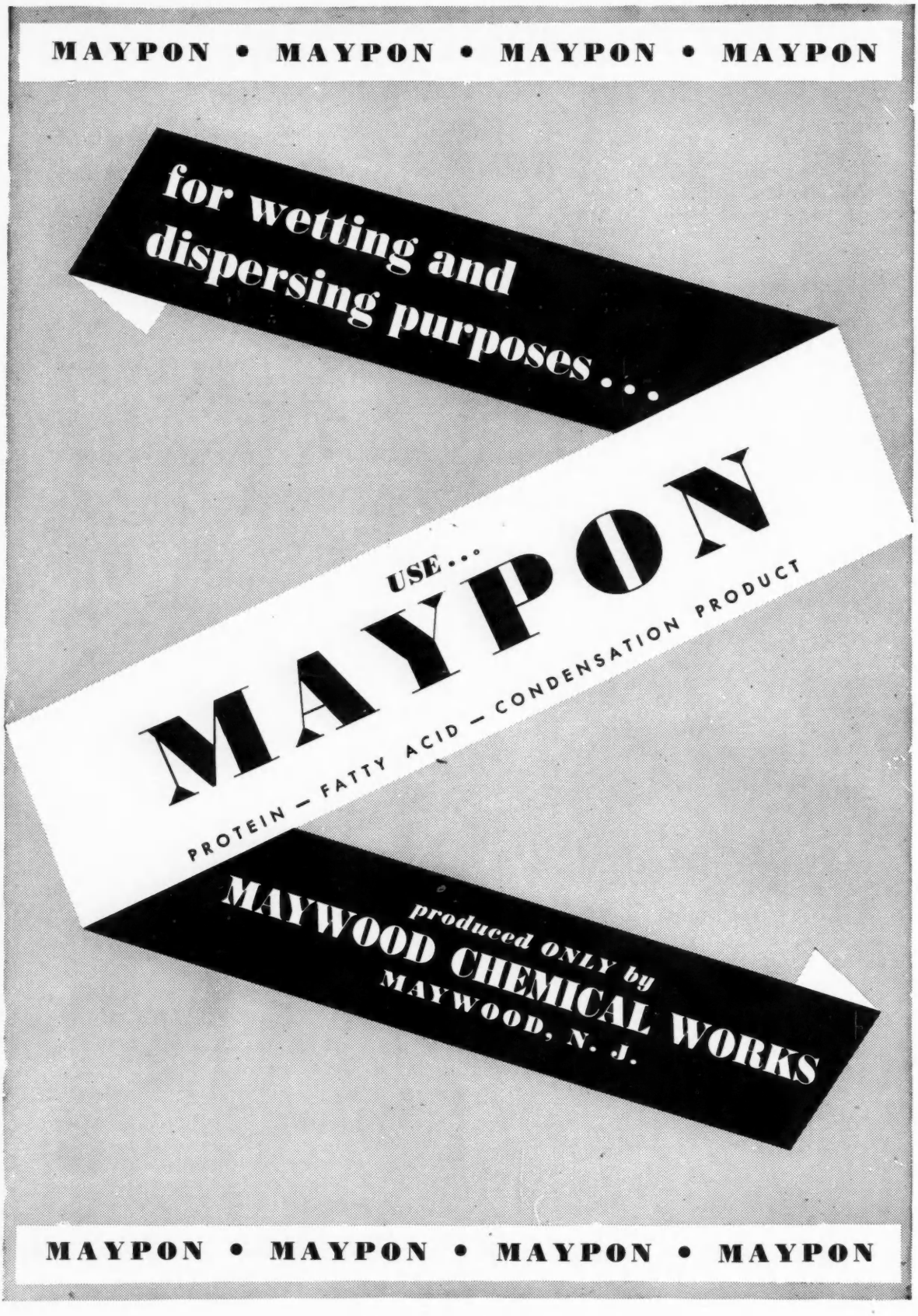
Laboratory Service with a Practical Viewpoint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for wetting and dispersing purposes . . .
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PROTEIN — FATTY ACID — CONDENSATION PRODUCT
produced ONLY by
MAYWOOD CHEMICAL WORKS
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Check these commercial acids

as workable intermediates for your product or process.

Butyric Acid

$CH_3CH_2CH_2COOH$ – Butyric acid and its esters are valuable flavoring and perfuming agents. Typical of its versatility in chemical synthesis is the production of propylthiouracil, promising antithyroid compound, and butanefrin, recently developed bronchodilator from butyric acid chloride.

AVAILABLE IN TANK CARS.

Caproic Acid

$CH_3CH_2CH_2CH_2CH_2COOH$ – Caproic acid is primarily used for the preparation of the antiseptic hexylresorcinol. Its ethyl and allyl esters are used extensively in synthetic flavoring agents. Its isomer, 2-ethylbutyric acid, is also available, and is employed in the preparation of drugs, and plasticizers.

AVAILABLE IN TANK CARS.

2-Ethylhexoic Acid

$CH_3(CH_2)_3CH(C_2H_5)COOH$ – The cobalt, lead, manganese and zinc salts of ethylhexoic acid are widely used as paint and varnish driers. These driers are stable, high in metal content, light in color, and practically odorless. Aluminum ethylhexoate has remarkable properties for jelling of hydrocarbons. Ethylhexoic acid is also used in the synthesis of other compounds having detergent, emulsifying, or plasticizing properties. AVAILABLE IN TANK CARS.

Call on our experienced representatives for help in applying these synthetic organic acids to your product and process problems. When writing for information, please address Department A-1.

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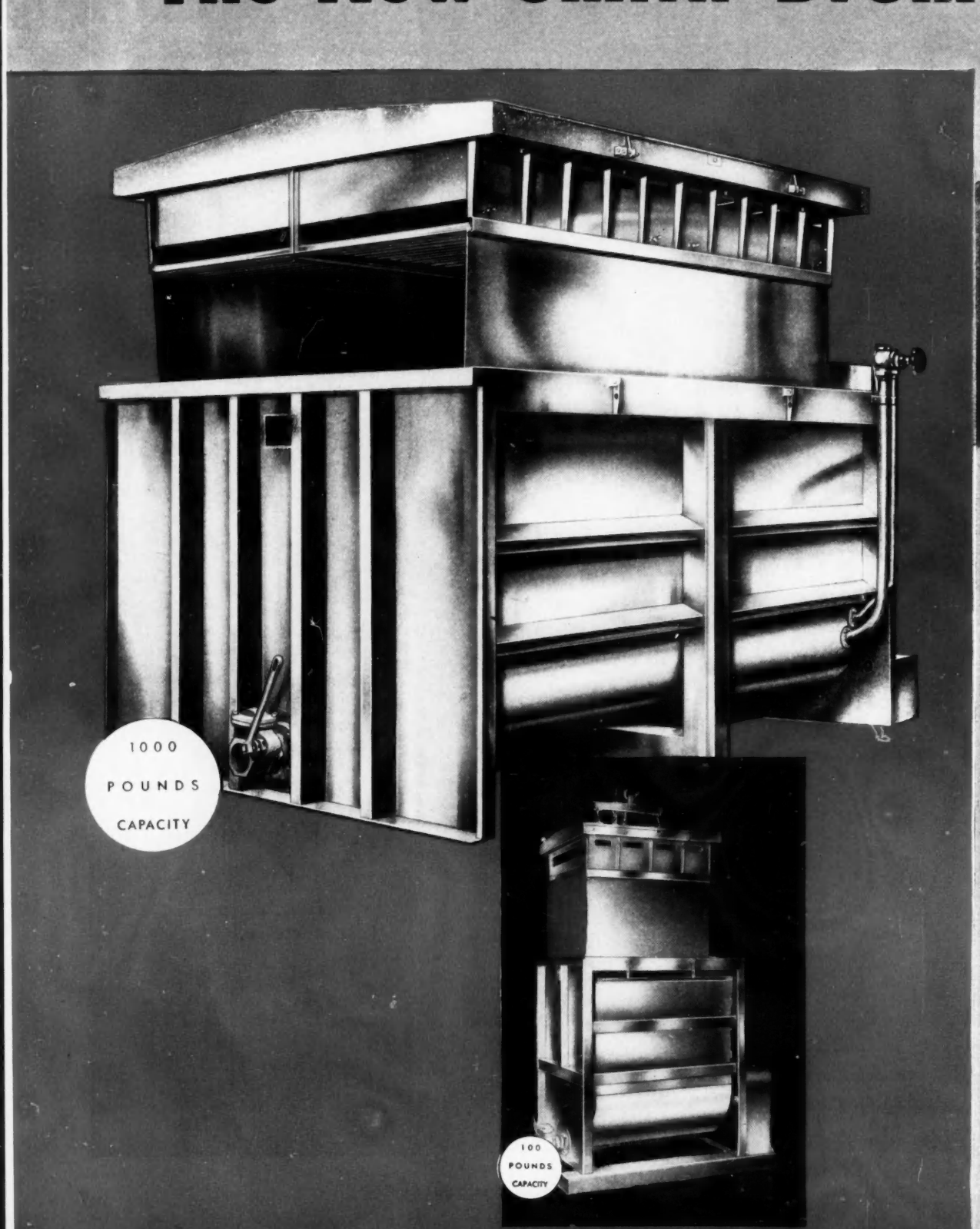
The New Smith-Drum



PULSATING

SKEIN DYEING MACHINE

This new "pulsating" principle for dyeing heavy woolen and worsted yarns in skein form has been applied for the first time in this country in the new Smith-Drum Pulsating Skein Dyeing Machine. The operation provides for automatic starting and stopping of the pump motor, according to a predetermined cycle. The dye liquor is forced through the skeins intermittently in a downward direction only. The results and savings which it makes possible are little short of revolutionary.

LEVEL SHADE AND UNIFORM QUALITY—No other skein dyeing machine for heavy woolen and worsted yarns can match this new Smith-Drum Machine for levelness of shade or for uniformity of dyeing results.

YARN FREE FROM SNARLS—Because the intermittent flow is in *one direction only* . . . downward . . . the yarn does not become felted or tangled, but remains in perfect condition for winding.

LOW LIQUOR RATIO—This new machine provides for an extremely low liquor to yarn ratio (approximately 10 to 1) . . . and results in appreciable savings in dyestuffs, chemicals, water and steam.

LESS FLOOR SPACE—The capacity of the machine is between 2 and 3 times greater than other types of skein dyeing machines of equal size, for heavy woolen and worsted yarn.

EASY TO CHANGE COLORS—Because there are no false bottom, steam pipes or other obstructions within the stainless steel dye tank, no foreign matter from previous dyes can collect. Consequently, colors may be changed after only a simple rinse.

AUTOMATIC CONTROL—Entire operation is automatically controlled, eliminating the human element and insuring uniform results.

The Smith-Drum Pulsating Skein Dyeing Machine is built in sizes of 100 lbs. to 1,000 lbs. capacity per batch. Write for complete information.

Under License by Samuel Pegg & Son

SMITH, DRUM & COMPANY

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NYANZA

ANILINE & ALIZARINE COLORS

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TEXTILE CHEMICALS

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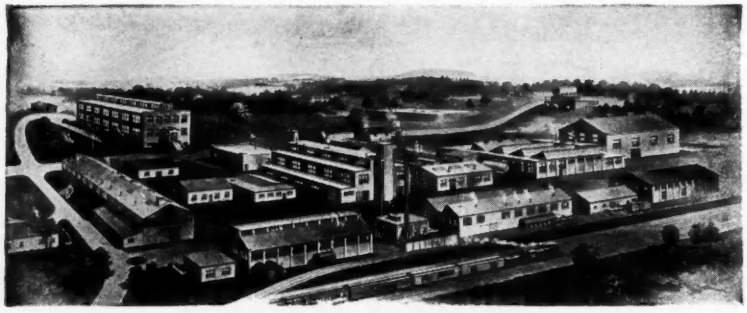
FOR

WOOL—COTTON—RAYON—ACETATE
AND MIXED FIBERS



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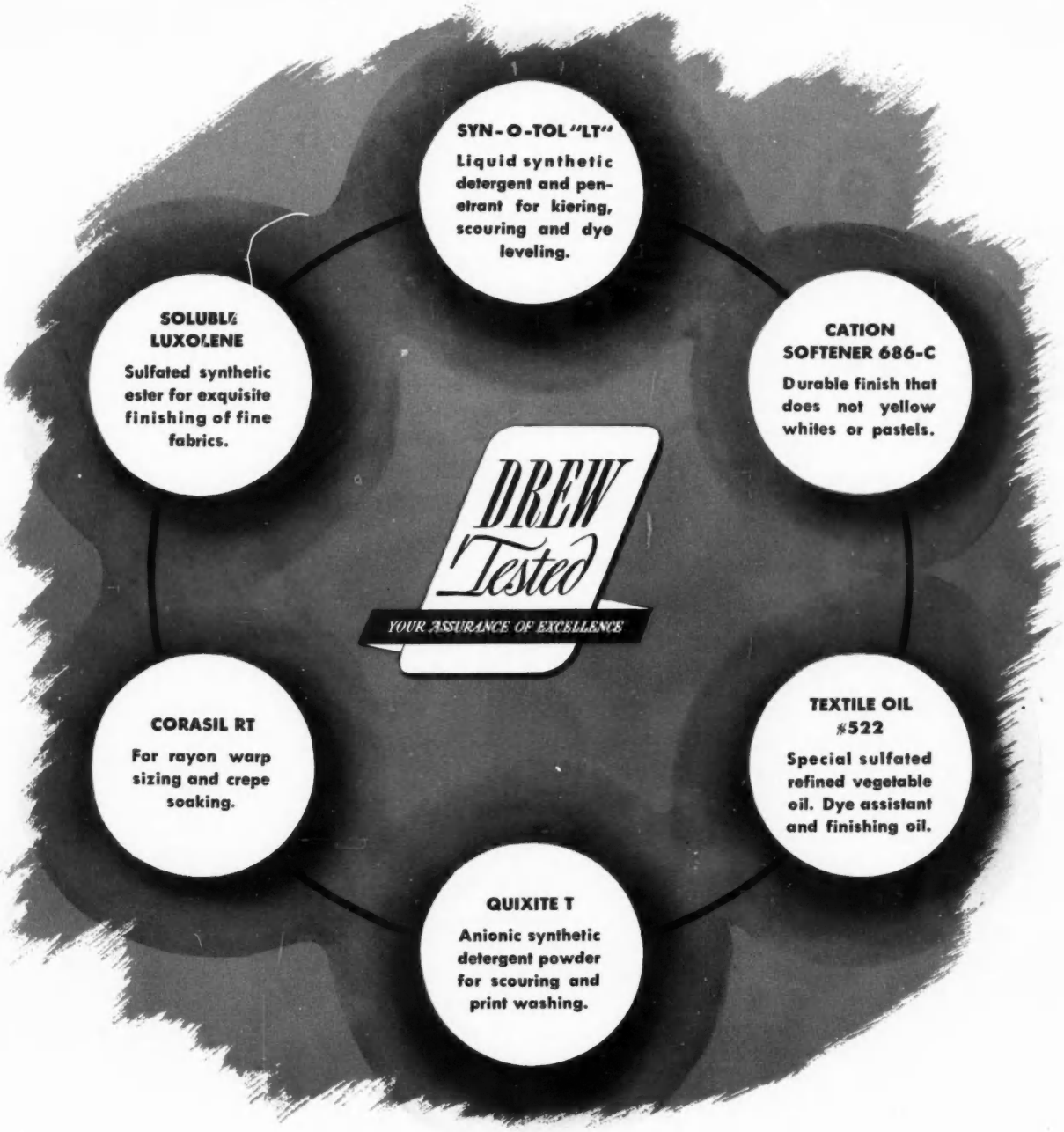
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SOLUBLE LUXOLENE
Sulfated synthetic ester for exquisite finishing of fine fabrics.
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This cation-active softening agent, newest item in the famous Onyxsan line, provides extra smooth, soft hands that are *permanent* on cotton, rayon and bemberg, and outstanding in their resistance to washing *on all other fabrics.*

All Onyxsans are easy to use in the jig, quetsch, dye beck, pad, etc. Substantive to textile fibers, small quantities do a big job. Stable to hard water, electrolytes and organic acids. They do not develop rancidity, odors, stiffness or mark-off.

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In order to concentrate the greatest possible attention on the growing field of aromatics for industrial purposes, and in order to develop fully the interest in new preservatives, stabilizers, germicides, anti-skinning agents, mildewcides and other industrial chemicals,

SINDAR CORPORATION

has been formed as a separate company to take over the activities formerly carried out by the Industrial Products Division of Givaudan-Delawanna, Inc.

During recent months, there has been an unprecedented display of interest in the utilization of odor as a merchandising aid. Manufacturers in scores of industries—rubber, textile, plastic, paint, paper and others—have sought aromatics, either for the purpose of imparting a pleasant, nose-catching fragrance, or to mask the objectionable odor caused by raw materials they were using.

Sindar Corporation will continue to sell the well-known industrial aromatics developed by Givaudan—including the Texodors*, Paintodors, Inkodors, Resodors, Paradors*, at the same time lending its efforts to the development of new aromatics to meet the needs of industry.

Sindar Corporation will furthermore be engaged in the development and sale of the Bartyls* and other effective anti-skinning agents; Compound G-4 and Compound G-11, fungicidal and germicidal chemicals; and many effective stabilizers and preservatives.

The pioneers in industrial aromatics now take this giant stride forward, in the organization of the first company devoted principally to this field, in order better to serve the interests of American industry.

*Reg. U. S. Pat. Off.

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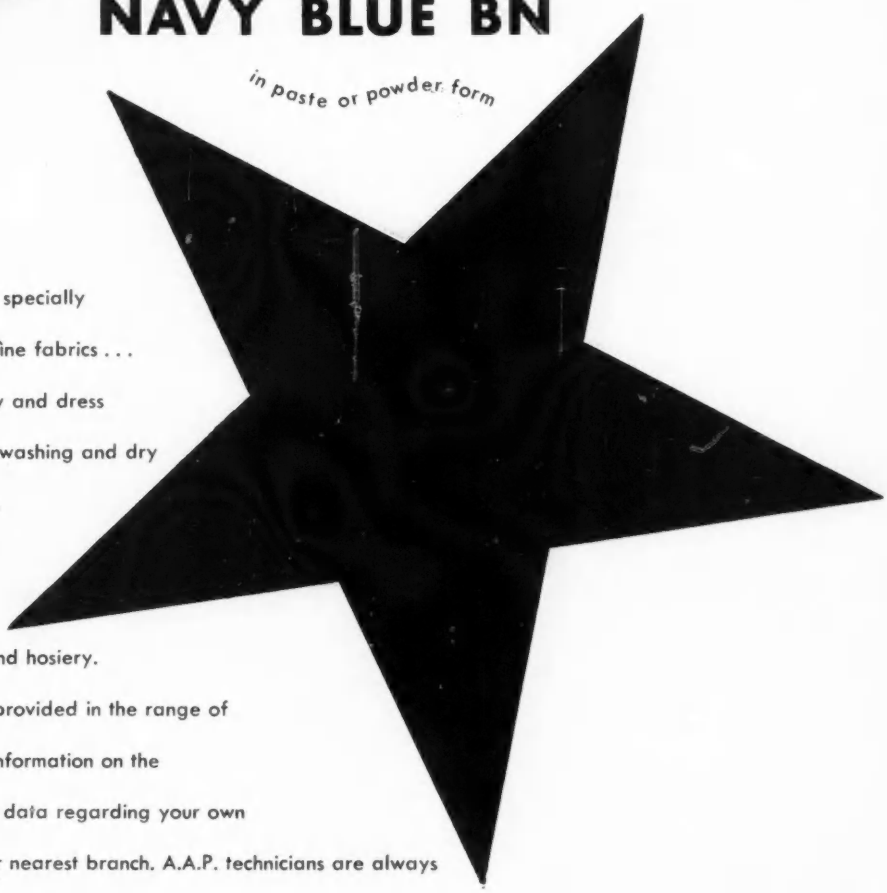
Branches: **Philadelphia, Boston, Los Angeles, Cincinnati, Detroit, Chicago, Seattle, Montreal, Toronto**

AMANTHRENE* VAT COLORS
provide the answer to the
demand for better
color fastness in textiles

Amanthrene

NAVY BLUE BN

in paste or powder form



An all purpose Vat Navy Blue . . . specially recommended for the printing of fine fabrics . . . particularly those, such as drapery and dress materials, where fastness to light, washing and dry cleaning is of primary importance. Regularly used for the dyeing of cotton and rayon piece goods, packages, beams, warps, skeins and hosiery. Just one of the handsome shades provided in the range of Amanthrene Colors. For detailed information on the whole range available, as well as data regarding your own particular requirements, consult our nearest branch. A.A.P. technicians are always happy to be of service.

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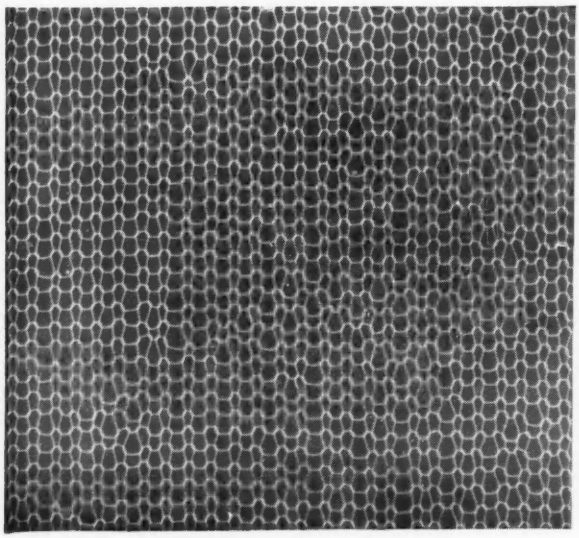
*Reg. U.S. Pat. Off.

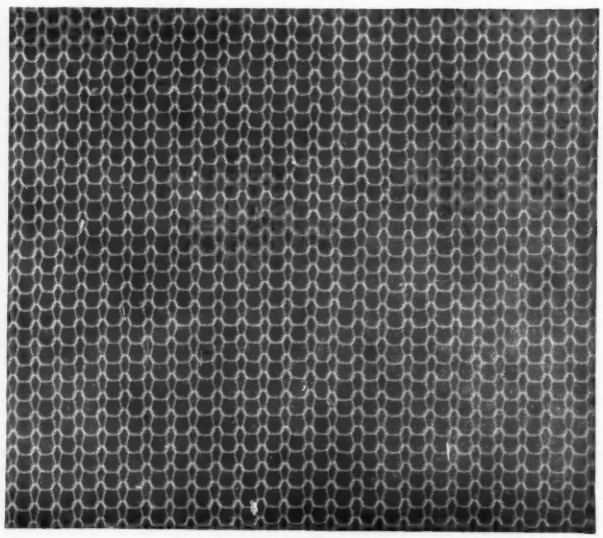
, 1948

Kōnrite

"TREATS" YARN "RIGHT"!



Here's fabric knit from conventionally treated yarn



Here's fabric knit from KŌNRITE treated yarn

See the Difference?

That's because KŌNRITE treated yarn gives the clear, perfect stitch formation so important in nylon hosiery of the finer grades. This new and unusual coning oil offers many other advantages, as well, that make for greater uniformity in Coning, Knitting and Seaming.

Write today for full information on KŌNRITE

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Formerly National Oil Products Company

BRANCHES: BOSTON • CEDARTOWN, GA.
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NOPCO TRADEMARK EVOLVED THRU RESEARCH

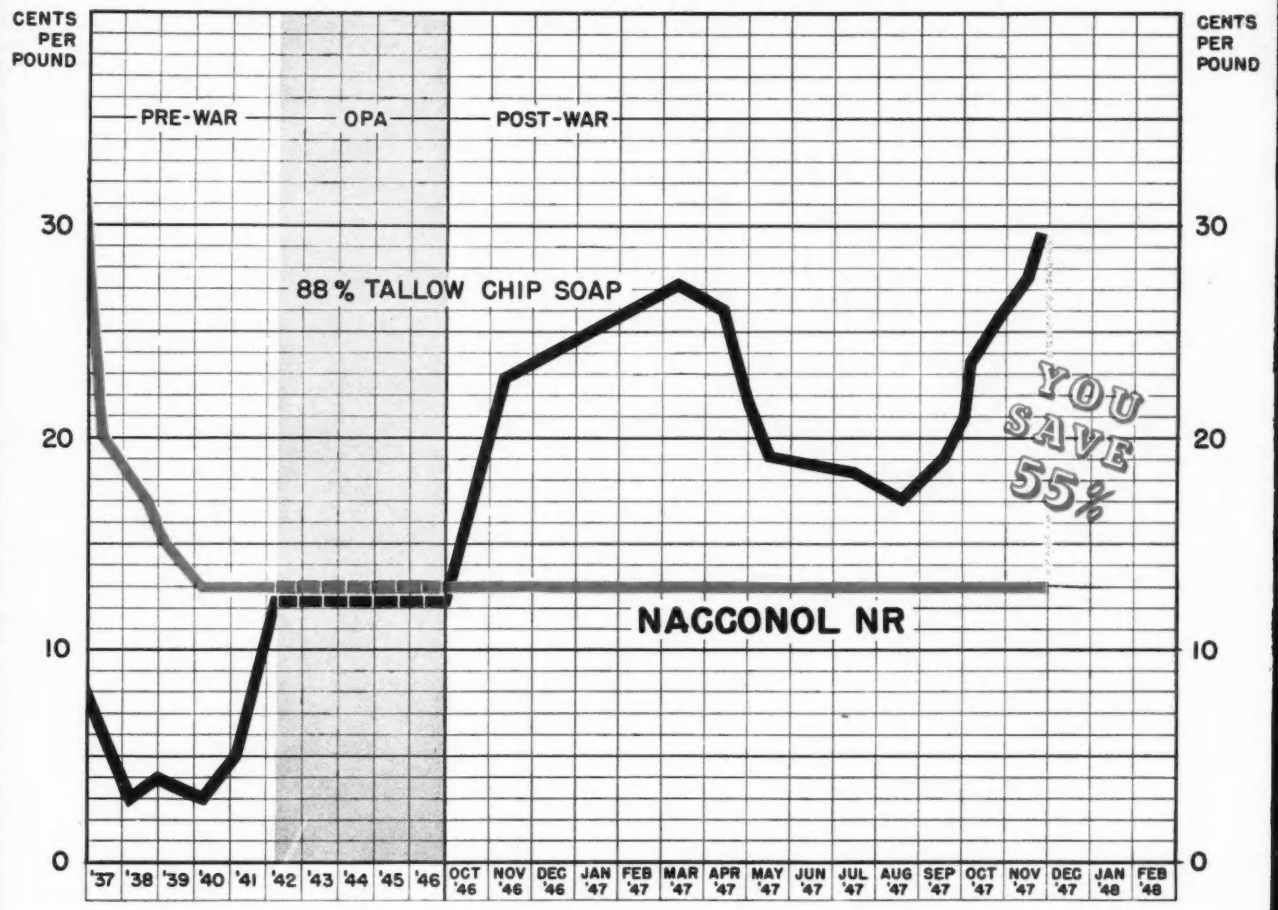
KŌNRITE ...

- ▶ **produces cones of proper density. Overlaps, crossovers and underwinds are practically eliminated. Increases cone production besides.**
- ▶ **yields uniform cones. Its controlled viscosity assures even distribution of oil on the yarn.**
- ▶ **minimizes stripping of size in knitting. Reduces press-offs.**
- ▶ **permits rapid cementing of stitches, resulting in a clear and perfect fabric.**
- ▶ **reduces curling. Increases seaming production.**
- ▶ **prevents softening in lagged yarn and fabric.**

Kōnrite — The Outstanding Nylon Coning Oil

Pictures Speak Louder Than Words

COST COMPARISON - NACCONOL NR vs SOAP


CENTS PER POUND
CENTS PER POUND
PRE-WAR
OPA
POST-WAR
30
20
10
0
88% TALLOW CHIP SOAP
YOU SAVE 55%
NACCONOL NR
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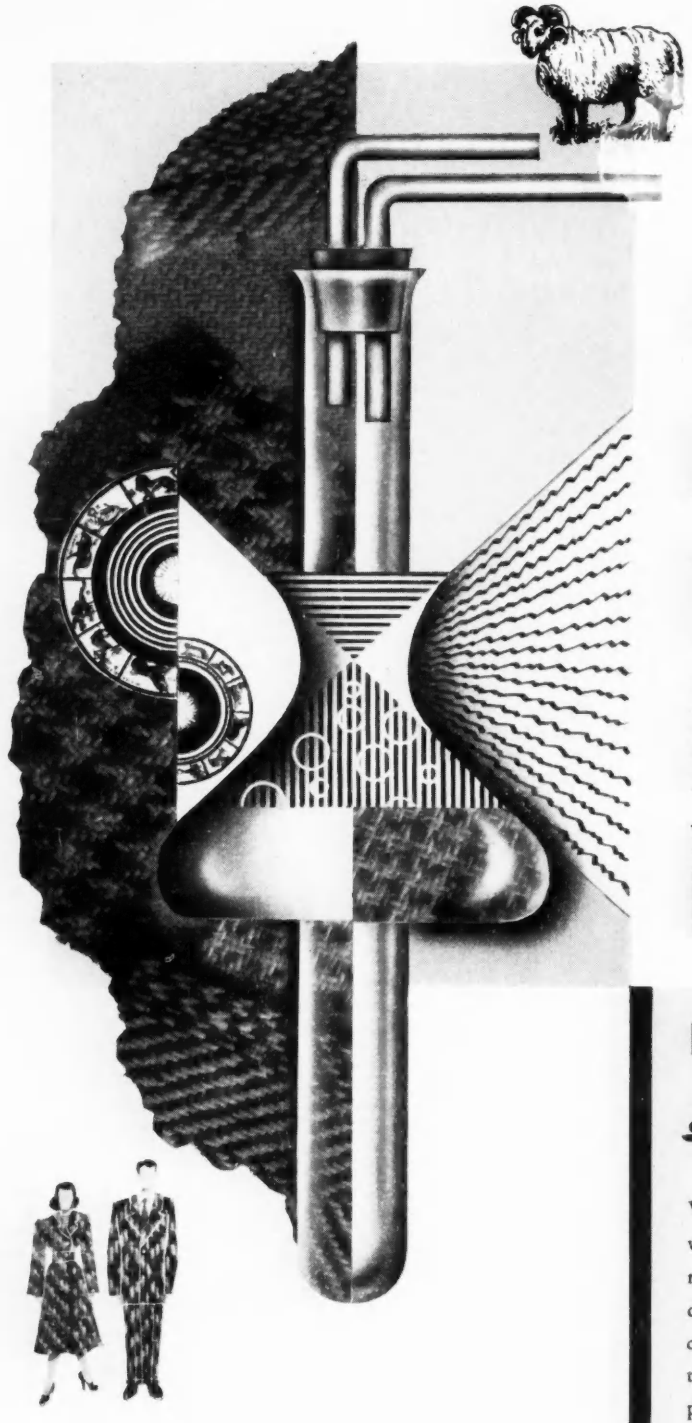

a new fabric is born

BUT...

How Will it Scour?

With a yard of your fabric in the grease we are in a position through our research laboratory to give you a complete detergency analysis. Join our many customers who are enjoying this service that offers you the most economical procedure for scouring your fabrics.

A Watson-Park representative will be glad to discuss your problems with you, or if you wish, just mail us the material you desire analyzed.

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The dependable, rapid and economical de-sizing agent for cottons, rayons and mixed goods. Applicable over a wide range of processes, temperatures and speeds.

HAS PROVED PARTICULARLY SUITABLE FOR CONTINUOUS DE-SIZING

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OLATE COMPLETES THIS FULLING "TRIPLE PLAY" WITH PRECISION

Fast wetting out . . . excellent lubrication . . . thorough emulsification of oil and dirt . . . this triple-play fulling job is one which Olate handles with exceptional efficiency.

1 Wets Out Thoroughly and Quickly

Olate's extremely low titer assures fluid solutions which penetrate fibers quickly and evenly . . . eliminate dry spots . . . guard against uneven fulling and non-uniform felting.

2 Lubricates and Softens

Fluid Olate solutions soften the fabric quickly, too. No uneven lubrication to cause uneven shrinkage and poor coverage when Olate is on the job.

3 Emulsifies Oil and Dirt

Dirt and oil are loosened quickly and emulsified thoroughly when Olate goes to work. Dirt is held in suspension until it is ready to be flushed away during the scouring operation.

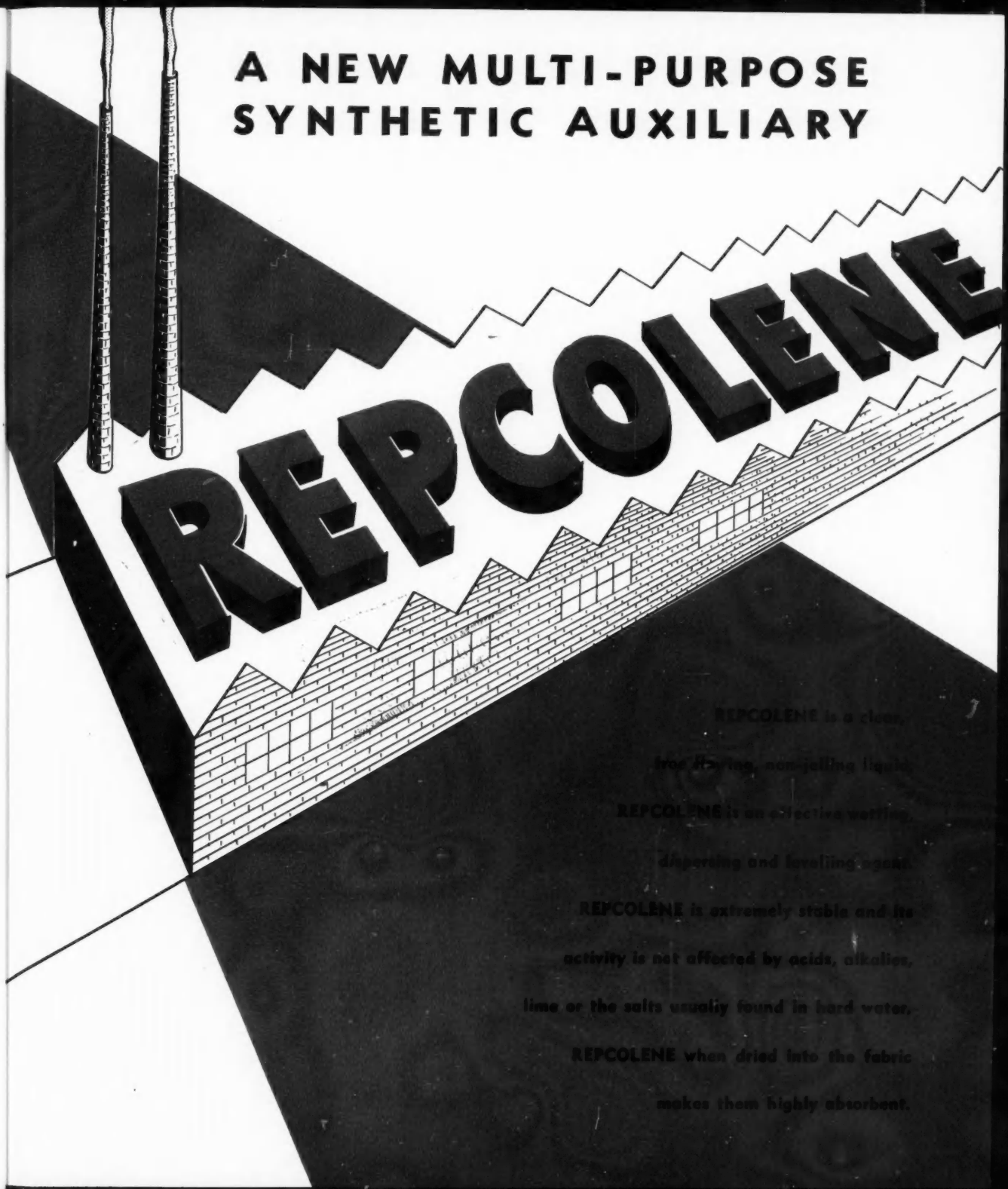
Olate can save you time, steam, and manpower in your fulling and scouring operations. Olate-processed woolens *look* better . . . *feel* better. Prove it with a month's trial.

Olate

Procter & Gamble

safe and efficient for every textile soap usage

A NEW MULTI-PURPOSE SYNTHETIC AUXILIARY



REPCOLENE is a clear, free flowing, non-jelling liquid.

REPCOLENE is an effective wetting, dispersing and levelling agent.

REPCOLENE is extremely stable and its activity is not affected by acids, alkalies, lime or the salts usually found in hard water.

REPCOLENE when dried into the fabric makes them highly absorbent.

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THE present price of Indigosol Golden Yellow IGK makes possible the use of this very fast Indigosol for economical dyeing and printing operations.

In combination with Indigosol Green IBA, very fast green shades are now available to the printer and dyer for the first time at a very reasonable cost.

An excellent printing color on cotton and rayon, it is also of great interest to the dyer of cotton, rayon and wool.

In ease of application, the perfectly level shades obtained, and the unusually excellent penetration of heavy goods makes the entire line of INDIGOSOLS especially valuable to the fast color dyer or printer.

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Pharmasol Golden Yellow N

PHARMASOL Golden Yellow N produces clear, bright, fast and economical golden yellow shades when printed on cottons or rayons.

When mixed with Pharmasol Red RN, a complete range of Gold Shades can be obtained.

PHARMASOLS are solutions of stabilized azoic dyes and adjusted to the most practical concentration which can be easily applied with a maximum of efficiency.

PHARMASOLS solve the problem of troublesome dissolving and the uncertainties thereof—and as there is no decomposition there can be no loss of material or value.

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Official Publication of the Proceedings of the American Association of Textile Chemists and Colorists

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January 12, 1948

VOLUME 37 NUMBER 1

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Non-Cellulosic Fibers Group Meeting
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Proceedings of the

American Association of Textile Chemists and Colorists

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JANUARY 12, 1948

Annual Banquet Session

Chicago National Convention, October 25, 1947

FOLLOWING the banquet on Saturday evening, October 25th, in the Congress Hotel, Chicago, Elmer F. Smith, Chairman of the Convention Committee of the Mid-West Section, spoke as follows:

"On behalf of the Mid-West Section, I have the pleasure of welcoming you to this banquet, the concluding function of the 1947 Convention of the National Association. Most of you have traveled a considerable distance to be present, and it is the hope of the Mid-West Section that your expenditure of time and money has brought you at least value received. It can be no secret that we in the Mid-West have hoped in spite of our distance from the larger textile centers for an attendance which would be worthy and representative of the total membership of the Association. In can also be no secret that we are all very much gratified and pleased by the excellent attendance and your apparent approval of the program which has been offered. The local Convention Committee wishes to gratefully acknowledge the fine assistance and cooperative spirit given by the national officers and standing committees of the Association."

Mr. Smith then introduced those at the table with him, finally George O. Linberg with the words, "And now it becomes my pleasure to introduce to you a gentleman who at Boston last year had the job I have this year, and so knows what it is all about, your Toastmaster for the evening, George O. Linberg, Chairman of the Northern New England Section."

Contest Awards

After thanking the Mid-West Section for its hospitality and well managed convention, and entertaining the crowd to the point of hilarity with a number of well chosen stories, Mr. Linberg introduced Patrick J. Kennedy, Chairman of the Intersectional Contest Committee, who in turn introduced Dr. L. A. Olney, Chairman of the Judges. Citing the excellence of all papers, but almost unanimous ratings by the Judges, Dr. Olney announced the award of the first prize to the Northern New England Section, the second to Philadelphia, and the third to New York.

Olney Medal Award

Then followed the award of the Olney medal to Prof. Edward R. Schwarz, with Kenneth R. Fox speaking on "The Medalist, The Scientist," and Walter J. Hamburger on "The Medalist, the Man." A. P. Howes presented the medal to Professor Schwarz, with the citation: "Edward Robinson Schwarz, pioneer, scientist, educator, humanitarian. Your vision, imagination, and perseverance have established textile research at the highest scientific level. As an educator you have won the esteem and affection of all who have been privileged to know you. Your humanitarian understanding of the personal problems of your students, friends and associates has paralleled the brilliance of your professional career." The addresses by Professor Schwarz and introductory speakers follow:

The Medalist, The Scientist

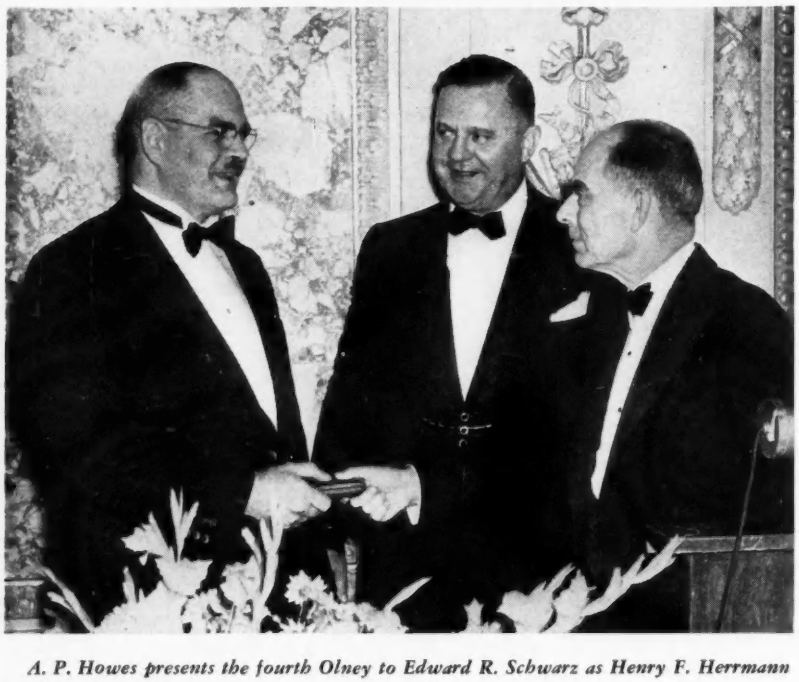
KENNETH R. FOX

THE present status and future progress of society can be measured by the quality of its participants. It has been shown by our historians that the levels of civilization in the past are governed by the caliber of men on the scene—and today presents no exception. Our future is wrapped up in the minds and deeds of our leaders both of today and tomorrow and this interdependence is irrevocable.

Tonight, we honor one of our contemporaries who has contributed much to our society and our industry. It is impossible to recount all of his outstanding achievements but an attempt will be made to acknowledge a few of his more renowned accomplishments.

Professor Edward Robinson Schwarz exemplifies a most versatile personality with an unusual combination of technical soundness and human understanding. Both of these traits have been put to excellent use in a most profitable way, namely, defining, introducing and interpreting to the textile industry the value of research. In an industry recognized as spending only a small fraction of gross sales on research and development, this task has not been a simple one. It has required an amazing amount of vision, fortitude, patience, and understanding tempered by the right amount of down to earth salesmanship. All of this, however, would be quite ineffective without the ability to translate into everyday language the terminology and nomenclature used by most research workers. Professor Schwarz has shown unprecedented ability along these lines putting into language we can all understand the benefits derived from the research method.

The continued successful sale of any product must be governed by its quality, and the sale of research is no exception. Our medal winner has done much to enhance the value of technical methods and the results they produce. It has been said that one of his greatest accomplishments has been the introduction of new concepts to the research workers pointing out their immediate usefulness in solving a number of industrial problems. Probably the outstanding example of this is the monumental work he has done in showing the



A. P. Howes presents the fourth Olney to Edward R. Schwarz as Henry F. Herrmann looks on.

wider application of the microscope to textile work, particularly in regard to fiber properties. We all know the value of his method in determining the maturity of cotton fibers, the optical properties of textile fibers, the quantitative determination of yarn twist under low magnification, the analysis of fiber, yarn and fabric defects, especially through the use of photomicrography. Another new concept he has introduced is that of novel physical testing techniques such as the M.I.T. abrasion tester, the Drapemeter developed under the sponsorship of our society, a photoelectric twist tester, resilience testing machines and many others. Recently, this work has taken on a most productive aspect through the use of the latest electronic control devices. The most spectacular of these has been the high speed tensile testing machine whereby test samples can be investigated to rupture in a small fraction of a second. On the other hand, he has not always been in such a rush to complete his tests and his work on the creep of textiles is recognized as being without parallel. The influence of the time factor in textile testing has been the subject of many of his papers and his unique presentation of the "memory" of textiles is both interesting and startling.

Still another concept is the application of simplified mathematics to the solution of complex problems. He pioneered in the field of nomography and showed how this tool could be used to advantage. Further, he has shown in many practical ways how statistical methods could be used in designing, conducting, and interpreting textile tests. Specifically, he has used rank correlation in many ways and has shown how the method can be helpful in the control of manufacturing quality. Work along these various lines led to the establishment of the Samuel Slater Memorial Research Laboratories as a gift to M.I.T. with the honor of directing the activities falling to Professor Schwarz. Here is concrete evidence of the confidence the textile industry has in his ability as a research worker.

One might be led to believe that our medalist already has taxed a twenty-four-hour day far beyond its limitations. But there is still another whole activity that has not been mentioned. Professor Schwarz is a recognized authority in the field of fire protection and safety. He has written widely on this subject and has been successful in showing personnel managers how important this subject is to the efficient conduct of a business. His efforts in this direction have resulted in his serving as President of the Massachusetts Safety Council as well as Chairman of the Committee on Fire Protection Engineering Education. Coincidentally, with this interest has developed a rivalry with the late Fiorello LaGuardia in chasing fire engines. It is not uncommon to see Professor Schwarz helping direct rescue efforts during fires in the metropolitan Boston area. Certainly, it is unusual to find such a combination of interests.

His membership and activity in professional societies read like a directory. Additionally, he is a Fellow of the British Textile Institute and the American Association for the Advancement of Science. He is a charter member of the old U. S. Institute for Textile Research and still serves as a Director in its present organization. Also he serves as a member of the Editorial Board for the Textile Research Journal. His interests likewise lie in such allied fields to textile research as physics, optics, biology, plastics, electronics, mathematics, and chemistry.

Only the lack of time prevents a more detailed and comprehensive survey of the immense contribution our medalist has made to our industry through his technical writings of over one hundred in number and his countless talks, both formal and in the classroom. Surely, if we are to judge the level of our civilization by the characteristics of Professor Edward R. Schwarz as a scientist, educator and humanitarian, we have little to fear in this age of atomic power.

The Medalist, The Man

WALTER J. HAMBURGER

EDWARD ROBINSON SCHWARZ: his contributions to the field of textiles are many and varied, and he stands a living monument in the field he strives so diligently to enrich.

While still a student at the Massachusetts Institute of Technology, he recognized the need for research in science applied to textile problems and began early in his academic career to prepare him-

self for this task which, even then, he knew would become his life work. He interrupted his studies to gain experience in textile mill problems and spent a year studying operations from the practical mill vantage point, a procedure not surprising to his friends, who knew his appreciation of the need of a broad horizon to assure success.

After returning to the Institute to complete his studies, he was appointed an assistant in the textile section of the Department of Mechanical Engineering, where and when he began to dream of a Textile Division designed to implement and instrument scientific textile research. The progress was slow and discouraging since it was next to impossible to interest industry or the Institute in the great need which he recognized so early in his career. Nevertheless, his indomitable will rekindled the fires of enthusiasm as rapidly as the encountered resistance attempted to quench them.

Under his direction and guidance, antiquated processing equipment which constituted the textile section was discarded and, in its place, the nucleus of a textile research laboratory was installed. Much of the research represented by his prolific contribution to the literature stemmed from this modest installation. The intervening years have seen great changes in the Textile Division of the Masschusetts Institute of Technology. Today, it can point with pride to the most modern textile research laboratory of any educational institution in the country, if not the world.

Since his early "pioneering" days, Profesor Schwarz has been aware of the demand for scientists in the field of textiles. He recognized that some formal educational program to create such personnel was a vital necessity if research in the sciences of textiles was to steadily progress from its humble beginning in the early twenties.

To this end, he developed a graduate school curriculum designed to prepare students in various fields of research activities in the textile industry—this, in addition to his continuing contribution to the scientific literature. But, as the educational program grew, he was faced with the problems attendant with expanding this branch of the work.

In the establishment of these new courses, Professor Schwarz must be credited with many "firsts." His methods of lecture and laboratory procedure in the instruction of textile microscopy are now used as standards in many other colleges. The introduction of the latest development of research techniques into his lectures and laboratory classes require a continual revision of the course material.

Face and Back of the Olney Medal

For those who have had experience in teaching, it will be recognized just what a herculean task this procedure represents. The results, however, are invaluable from the students' point of view.

Seminar sessions in which the students prepare papers on current research problems and present them to their fellow classmates, lay the foundation for skill in lecturing and in the presentation of professional subject matter.

Visual aids in presenting the difficult to envision three dimensional aspects of fiber, yarn, and fabric, geometry—such as the Readix instrument; three dimensional schematic fiber, yarn and fabric models, stereoscopic photomicrography and photomacrography—all may be credited to our Medalist.

As a result of these advanced methods of education the Graduate School of the Massachusetts Institute of Technology conferred, in 1940, the first Master of Science degree in Textile Technology offered there, or at any other institution of higher learning in this country.

By this accomplishment, Professor Schwarz has established Textile Technology on a professional level with other fields of science and engineering—a place it deserves and will continue to occupy.

As an educator, Professor Schwarz stands unique in the field. He has produced research scientists who are the most outstanding testimonial of his great ability to inspire and develop men. Many of his former associates on the instructing staff and faculty have achieved positions of importance in both the industrial and academic worlds.

His consideration for and interest in others is exemplified by the generosity with which he graciously shared authorship of many publications with members of his staff, and by the support and assistance he gave to his associates in attaining new heights in their professional careers, even at the sacrifice of his own interests.

There is another side to the man. And here, he must be alluded to as Ed Schwarz, because the jovial, fascinating personality which is so completely and individually his, while evident from the lecture platform, has a very personal side which is probably known to only a favored few of us—he is an amateur magician of no mean account; and many the night, while some of his students were busily at work in the laboratories did he appear in the doorway unannounced and display his bag of tricks! Of course, the work stopped. Who could resist? One night in particular can be recalled when five or six students were so entertained in a laboratory, the windows of which faced the infirmary. In but a few minutes, all who could leave their beds were crowded to the windows. The beds of others were wheeled into front line positions and an audience of some fifteen or twenty student patients were entertained "far into the night."

Nothing pleases Ed Schwarz more than to please others.

Over the years, he has endeared himself to all who have had the rare privilege to know Ed Schwarz, the man, and the great honor which is to be bestowed upon him tonight is but a token of the respect and esteem in which he is held in the great field of his cohice. And now, Ed, I must inject a personal note into this introduction. When I do it is not to be construed as my words, thoughts, and sentiments alone, but rather those of all who have had the rare privilege to work with you over the years. Edward Robinson Schwarz —Pioneer, Scientist, Educator, Humanitarian. To these qualifications, we add another—more glorious—more coveted than all others—Edward Robinson Schwarz—*One of God's Noble Men!*

Address of the Medalist

EDWARD R. SCHWARZ

I SUPPOSE I would not be human if I were not gratified very deeply indeed as an individual to receive the Olney Medal at your hands. But I cannot accept it as an individual and do so with a clear conscience. Credit in no small part goes to a great many students who have gone through the work at MIT, no few of whom are in this room. It is with a little pardonable pride that we note one of them as the presenter of the prize-winning intersectional contest paper this morning. No one, I think, can really know any subject unless he has tried to teach it, and credit, therefore, goes definitely to the student body who have taught me much of what I may know.

Together with credit to the students goes credit to colleagues, for advice, for encouragement, for inspiration, for support. I want to pay tribute particularly to several men who have gone on, to whom I would have liked to pay the tribute face to face. The first of these is Samuel Wesley Stratton, then President of MIT, later chairman of its corporation, and the first president of your sister organization, the Textile Research Institute. He was in no small part responsible for the initial spark which made the research laboratories in textiles at MIT possible.

I want to pay tribute also to the late Edward Furber Miller, for many years head of the mechanical engineering department in which the textile division was born and still is located; and to Charles Ladd Norton, for many years director of our division of industrial cooperation, and himself a pioneer in many textile research problems, one of the first in the country to make cross sections satisfactorily of cotton fiber, and one of the first to spin successfully discontinuous filament yarns in a high frequency electric field.

And credit to the living: Particularly to Karl Taylor Compton, now President of the Massachusetts Institute of Technology, whose support, encouragement and advice have been unfailing throughout his whole administration; and to immediate associates and colleagues on the staff over the past 25 years: Messrs. Broadfoot, Hotte, Sieminski, Yelland, Bellinson, Toas, Norcross, Hindman, Hamburger, and Professors Fox and Finch; and I think above all, for the encouragement and the very definite inspiration that has come from the man, then dean of engineering and later Vice President of MIT, now known to everyone in the country, Dr. Vannevar Bush. Fifteen years ago Dr. Bush wrote, in an introduction to "Textile Research, A Survey of Progress" (a volume, incidentally, edited in large part by the man whose likeness appears on this medal Dr. Olney) the following words:

"There has been a great deal of time and effort wasted in improper or in untimely research, and a moderate amount of distrust on the part of laymen is entirely justified with respect to the type of research which consists simply of mixing things up or measuring something without really knowing the goal and with no correlation with the recorded results in the literature of the subject.

"The idea, unfortunately, is prevalent, that one may buy a research laboratory ready-made from the scientific research man, and by hiring a doctorate graduate and turning projects over to him, be securely embarked on a program that is bound to bring results that will revolutionize a part of an industry and cause it to produce desirable products with a high margin of profit.

"The trouble with that scheme is that there is everything present but the program and the mature and experienced brain to guide it. There is not the slightest question but that well-directed and intelligent research pays, and pays well, in any field in which there are important problems to be solved. There are sufficient examples of this all about us, so that the thesis no longer requires demonstration. There need be no distrust of intelligent research and the results thereof."

I suppose that the last ten years have been characterized more than any preceding period by the increasing excellence of the textile research training that is being offered by our institutes, our textile schools, and the textile departments of our colleges; and this insures important research results. The question is, what are these results of textile research?

They are, first, not the instruments which are increasingly available in number and in quality and in precision—amply evidenced at any one of these conventions by the exhibit section of the convention. It is emphatically not the data which is accumulated by the experimenters using this equipment. And I fear that there is real danger that we have accumulated much too much data for its own sake. Only as these figures are correctly arrived at and efficiently used do they lead to real results of value.

I am afraid that too often we have allowed to creep into the literature printed information which is inadequate as to source, and inadequate or lacking in interpretation, and hence lacking definitely in value. Much of it has led to misunderstanding and to results which are anything but good.

For example, some years ago extensive tests were carried out on grey cotton cloth of wide range and weights and weaves, to determine the effect of moisture regain on the tensile strength. There was lack of agreement which had been causing difficulty among laboratories and government bureaus, and which came to a head at the beginning of World War I. A considerable amount of data was published, and it was shown that the strength could be increased in cotton grey goods by a percentage of the bone dry strength per percentage moisture regain increase. And unfortunately, two figures crept into the literature, with a little bit more emphasis than perhaps should have been given. They were, respectively, six and seven per cent; and they were widely adopted and far too widely used not only for cotton, but for almost every other type of fabric known, not only for grey goods, but for finished and dyed and mercerized materials, and extended in some instances to yarns and cords. That sort of blind use of figures is exactly the thing which we must avoid if we are to have worthwhile results in research.

One other illustration: Some years ago square woven tire fabric was developed made of 11/23s combed Egyptian cotton. The tension necessary to straighten but not to stretch the yarn of that fabric was painstakingly determined as a result of hundreds of tests, and 75 grams turned out to be the average tension. Someone whose name we fortunately, I think, do not have, was inspired to take that 75-gram figure and multiply it by 23, divided by 11, (which turns out to be the equivalent single counts of the yarn), arriving at a mystic number 156, with which you are all more or less familiar—although I hope not.

That 156 was alleged to be a magic number, which, when divided by the count of the yarn that you happened to have,

EDWARD R. SCHWARZ
Fourth Olney Medalist
Awarded October 25, 1947

would give the tension in grams to straighten but not stretch. That was extrapolation extrapolated and then extrapolated again.

In 1931 a series of tests were made in self defense, indicating that the errors introduced by the use of that figure 156 ran from 40 to 800 per cent. That was published, but it didn't seem to have as widespread reading as its predecessor publication had had, for two weeks ago we found that the mysterious number, converted into the Typp system, and appearing as 131, in accepted good usage; this, in October, 1947! I don't think we need additional examples to head up the fact that we have research results which are not the kind that we really want.

We have obtained another magic number known as a mean or an average. It is much more legitimately a magic number than that 156 or 131 could ever be, but it still is relatively uninteresting and unimportant by itself. If two numbers differ numerically we have been prone to say that they represent differences in the things they represent. A grey fabric may test 80 pounds in tensile strength, and after bleaching, 76 pounds; and the four-pound decrease is attributed unhesitatingly to the bleaching action. And possibly a good many thousand dollars—and this has happened—may be spent to check that four-pound differential, later the investigator checks and finds that the bleached fabric tests 82 pounds. Thus, there is no significant difference between these figures in the light of the variations which must have existed in getting them.

The mean or the average by itself, then, is a datum which is not only inadequate, but can be misleading. We are concerned, then, not so much with the equipment, design, and operation, but with the adequacy and intelligence of the interpretation of the data that result from their use—and powerful tools are increasingly available for doing this.

Correlation analysis has already been spoken of. It roughly measures the tendency to agreement of trends, when these trends can be plotted as straight lines. We had excellent examples of those in several instances in the intersectional contest papers this morning. The result of correlation studies is a coefficient ranging from minus one through zero to plus one, but too many compute coefficients whenever they suspect a trend or whenever they have plotted data of any kind or even tabulated data of any kind; and because they hope to get a correlation coefficient approaching one, they therefore are sure that there is a cause and effect relationship. That does not follow. We may say that the textile literature is literally peppered with illegitimate correlation coefficients.

It is perhaps comforting to know that the industry recognizes that there is such a thing and uses it, even if not correctly. Rank correlation has come into use in this country thru early work done under the auspices of this Association, on one of its projects at Tech connected with the evaluation of textile finishes. It will do certain types of things for you that other types of correlation analysis will not do. It is a means of relating qualitative observations with each other, quantitative observations with qualitative, quantitative observations which differ in their units and hence cannot be compared otherwise, and quantitative information which has irregular sequences or intervals between readings. The initial work for this Association was done in 1938, almost ten years ago. I think it is time we used it.

Then there is the control of variable factors. I think we have been through three eras in this regard, the first of which was an era of no control at all. Then we realized that that was wrong and that we couldn't get consistent results until something was done about variation; and we moved into an era of complete control. So absurd were some of the tests set up then—and we were just as bad offenders as anyone else at the time—that we set up so many controls that nothing was left to be measured. We are now passing into a third era, which is not no control, and not complete control, but an analysis of the magnitudes of variations which factors can and do produce.

Suppose we have three factors, A, B, and C. The tendency on the part of most research workers is to hold A and B constant at whatever cost of time, expense, and effort; and measure C; and then to hold B and C constant, and measure A; and finally to hold A and C constant, and measure B. You then have results of A, B, and C measured, and you proceed to try to relate those with service tests or with consumer satisfaction; and you find in most instances that there is no relationship. In practice, A, B, and C all vary, not with any one or two of them under control; and there seems to be no real reason why you should find correlation between laboratory data where two or more have been controlled, and data where none of the observations were controlled.

The question you should ask now legitimately is, so what? And the answer is, modern statistical methods allow us to use an analysis of variance, not at all difficult to compute, involving nothing but ordinary arithmetic, by which, if the tests are properly planned and executed, and if you know before you start the test that you are going to use this method, you may make excellent estimates of the amount of variation which each of these factors is contributing; and you don't have to control it. Recent papers are beginning to carry analyses of variance as routine matters. It is an extremely important development, and one which should go further.

Graphics is another case of interpretation of data, and in many instances we plot a curve and call that the result. That is not the result by any manner of means. It is the discussion of what that curve indicates that is the important thing. The difficulty is that most plotted data results in curves to which equations should be fitted. Those equations then express behaviours, which may develop into hypotheses, or even graduate into theories—and far too often they graduate into *pet* theories, or pet theories already established are forced to fit the curves.

You can take any curve, however complex, and fit it almost exactly, if you use terms enough and coefficients enough and Greek letters enough, and exponents enough; and the fact that you do get a fit for the curve mathematically is no sign that the exponents or the Greek letters or the coefficients have any scientific, physical, chemical, or biological significance. And yet, over and over again this signifiance is drawn. I sometimes look across the floor of a laboratory and wonder why it isn't littered with battered coefficients, Greek letters, and exponents.

To insure results of value, you must first decide why it is you are doing the work at all, what it is you are measuring, and then how you are going to measure it, and how you are going to interpret what you have measured. The measurements themselves are only a means to an end.

There is an increased combination of chemistry, physics, biology, and mathematics in the work of the American Association of Textile Chemists and Colorists, and this work calls for a fundamental program, really to try to develop a study of effects of chemical structure on the physical, optical, and biological properties of our textile materials. We should be using the brains of the Association and of its research staff to multiply, not so much the data, as the results of proper interpretation of that data, so that the results of the research of this organization may increase and multiply fruitfully throughout the earth.

* * * *

Concluding the evening program and the convention were addresses by Henry F. Herrmann, President of the Association, and Dr. Roger Adams, Head of the Department of Chemistry of the University of Illinois. Mr. Herrmann's address follows and Dr. Adams' address will appear at a later date.

The President's Address

HENRY F. HERRMANN

MR. TOASTMASTER, Honored Medalist, Dr. Adams, Fellow Members and Guests!

It gives me great pleasure to accept the greeting of the Mid-West Section in the name of the national officers, the Council and membership at large on the occasion of our 26th Annual Meeting. Most of us, including many of the members of the Mid-West Section, have travelled long distances to attend this convention and have had to drop our business activities for a day longer than usual. For this sacrifice the administration is thankful and I am particularly happy that the good attendance proves the point we wish to drive home that we are a National Association in *fact* as well as in name. When we last met in Chicago, in the year 1933, the Century of Progress World Fair was a powerful medium of attraction. Today, we have only our members' loyalty to their Association, their interest in its proceedings and their faith in its plans for the future to induce them to make this sacrifice of time and money. I am sure that what you have seen and heard is full compensation for your decision to attend.

So many epoch making events occurred since we last met here that it is difficult to pass them by without some mention. However, we are here to discuss the affairs of our Association and I wish to devote my *entire* talk to a better understanding of who we are, why we are associated in the body of the AATCC and, above all, the role we play in the affairs of the textile industry. Much of what I will say may be an old story to those of you who have frequently attended our Annual Meetings but I have at heart our good fellow members of the home section and other districts remote from the eastern seaboard whose personal contact with our Association is more limited and who know us chiefly through the vehicle of our Proceedings in the AMERICAN DYESTUFF REPORTER and our Year Books. You are subscribers to these publications as a secondary privilege. First and foremost you constitute an active national organization. We have over 5,000 members—individual and corporate—and it is our desire—I might say our determined aim—that the majority of this membership shall feel a much closer sense of affiliation with the national body than has been the case, and that there shall be a great increase in your overall participation in its activities. The seed for our Association was sown in the East and for many reasons it is understandable that the principal growth and technological activity developed there. However, we are not bound by any precedents or sectional limitations and it is our desire that our Association shall function equally throughout our country wherever the textile industry may be located. We are of this industry and our activities are integrated with it regardless of the incident of geographic situation.

The AATCC was founded 26 years ago to constitute America's scientific society of textile chemists, colorists, dyers and others who are interested in the technical advancement of this country's textile industry. This step was taken a number of years after the end of World War I, when it became apparent that the American Chemical Industry was determined to make this country independent of foreign supplies of dyestuffs and fine chemicals. During the domination of foreign interests in this field prior to the first war practically all of the technical work related to the application and evaluation of dyestuffs and all manner of standards and testing methods had their origin abroad. Naturally, with our growing commercial independence it was quite logical that we should also assert our technological independence in the various phases which concern this Association.

It is well to restate the fundamental objectives of the AATCC, which are:

1. To promote increase of knowledge of the application of dyes and chemicals on the part of the textile industry.
2. To conduct and sponsor research in practical problems on chemical processes and materials of importance to the textile industry.
3. To establish and maintain quality standards and correlating testing methods whereby the industry is enabled to regulate itself from within on a practical basis.
4. To provide for its members channels for the free exchange of ideas and professional experiences for the benefit of the industry.
5. To serve as a lasting educational medium for the technical personnel of the industry by keeping its members informed on new developments. The lack of such knowledge would seriously hamper those who are not so situated so as to have ready access to other sources for such information.
6. To make possible a number of publications dedicated to these purposes whereby the Proceedings and other leading technical articles are made available to all its members.

Added to these avowed objectives which our founders had in mind there have developed other functions which have grown so important that they sometimes overshadow the original ones. One of these is the opportunity which our Association provides for meetings, conferences and pooled endeavors between representatives of the textile industry and of the affiliated dyestuff and chemical industries for the analysis and solution of mutual technical problems for which no better medium could possibly be found. These problems are so broad that they do not belong to any one concern individually. The solution in turn is of such widespread interest that it should be the property of the industry at large. We know of no other way in which these industries can be harnessed to a common cause so as to do for all that which would be out of the question or too costly for any individual concern to tackle.

Another more recent phase of our work focuses the attention of the country in general, and of certain government agencies in particular, on our fastness standards and our testing methods. Being a democratic country we believe in self-rule and this applies emphatically to the textile industry. The greatest asset toward the achievement of this end is a community understanding of the definitions of quality and durability in use by the textile industry. If the industry itself recognizes and adheres to these standards the consumer can be taught to understand them and any government regulations which may hereafter be contemplated will follow along the logical lines of the factual trail which our Association is blazing.

In view of the fact that our Association is composed of practical mill men who are either weavers of cloth, dyers, printers or finishers of these fabrics, or control chemists and have direct access to unrestricted technical conferences with equally skilled technicians of the dyestuff

and chemical industries, their labors and conclusions are bound to be practical. Any standards and testing methods on which they agree can be expected to be acceptable to the industry in point of reproducibility on a commercial scale. Needless to say in these conferences the keynote is facts and business considerations are subordinated to science.

One of the fundamental developments in our work has been a definite change in our point of view on textile standards. It is reasonable to state that 25 years ago very little thought was given to the desires of the ultimate consumer of textile materials. Standards and testing methods originated with dyestuff manufacturers working independently of one another both here and abroad, as aids to the merchandising of their wares to textile mills. Various degrees of fastness, justifying different price levels, as in the case of claims for fastness to wet processing, were of particular interest to mills for the purpose of helping them to get their production on the market—clean and saleable. As regards the ultimate consumer the doctrine of "caveat emptor" usually ruled even though it was not openly announced. With the growing interest in such matters on the part of organized consumer groups great pressure has been brought on the industry to identify its production in terms that would indicate the suitability of fabrics for specified end uses. At first glance this appears to be a simple and reasonable proposition but the more one delves into it the more complicated it becomes. The AATCC does not claim to have the solution to a complete understanding between the manufacturer, middle-man, consumer and regulating agencies but it has paved the way as no one else has offered to do, and, in our opinion, could do, to bring about such understandings through the evolution of acceptable standards and practical testing methods which are prerequisites toward this objective.

I consider it worthwhile to dally a moment over matters which we *disclaim* to have any interest in from an Association point of view. I have often said, and wish to repeat most emphatically, that we set up standards and devise testing methods but we do not attempt to *enforce* them or to *impose* them on any individual or industry which prefers to proceed otherwise. It is unavoidable that some of the problems which concern us from a technological point of view also acquire commercial importance and in some instances are of interest to state governments, as well as to the federal government for purposes of regulative legislation. On such matters the Association insists on maintaining complete neutrality. Where our opinion is considered expert we are glad to testify for either side on the technical facts which our committees have evolved. As a matter of official policy we refrain from expressing any views as to the ultimate use which this information should be put to, either legislative or commercial, since this is not our function. We acknowledge the fact that our membership as a general cross-section comprises the employees of the industries which we serve and that it is not our place to dictate our decisions to the corporate interests which employ us. For the public good our facts are freely available but what is to be done with them is the responsibility of those factors which have either a financial or a legal stake in the outcome.

I do not wish to take the time to discuss the research program of our Association since the subject is too important to be treated lightly. Those of you who have attended the meetings of the Research Committee have learned first hand from the Chairman of the Research Committee, our President Emeritus Professor Olney, and from the reports of the chairmen of the various sub-committees, about the work which is now in progress. J. R. Bonnar, Chairman of the Executive Committee on Research, during the meetings, as well as in his address the night before last, gave further information on our present activities and our expanding plans for the future. I call your particular attention to the fact that all the research projects which we pursue and the new investigations which we are planning to take up are of a very practical nature and fall within the capacity of our knowledge and resources to accomplish. It is our conviction that the solutions to these problems will be of immediate value throughout the industry because they pertain to recognized problems on which no other group is working in a collective sense.

One must inevitably come to the consideration of ways and means to carry on the program which we have set up for ourselves. In years gone by while our Association was small we relied entirely on the volunteered services of our members. Committee work was mostly done by individual members in their respective laboratories and as circumstances might warrant groups would visit one or another laboratory in order to make joint observations. The research program was supervised by Dr. Olney and, in his capacity of Chairman and Director of Research, he contributed services to the Association and to the industry for which no adequate thanks can be given. Obviously, Dr. Olney could not continue to carry on this work single handed and, accordingly, during the past few years, we have set up the Executive Committee on Research to relieve him of administrative duties and have engaged the services of a Technical Director to supervise the details of committee work, as well as to manage our salaried staff with headquarters at the Lowell Textile Institute. The general principle of our operation remains the same, namely, the Research Committee comprises active and reference sub-committees to each of which is assigned a specific project. The committees do as much work as they can with their own laboratory facilities but when tests are required which exceed the scope of services which are obtainable on a voluntary basis Dr. Stiegler takes over and assigns the required work to one of the Association's staff. The Institute laboratories not only assist the research committees with this sort of work but they take over entire projects which are then merged with committee work under the direction of the Executive Committee on Research.

It must be evident to all that the research work on quality and durability standards which the Association voluntarily undertook many years ago has grown in direct proportion to the degree that it is being accepted by the industry for essential maintenance purposes. Having initiated this work and now in exclusive charge of it our Association is under considerable pressure to keep its standards under continual review and to modernize them whenever circumstances warrant such a step. What was undertaken as a modest contribution to the industry has developed into a sizeable burden which requires the best professional talent available to us with an ever growing financial outlay. A few years ago, when it became apparent that we would have to set up our own laboratory facilities and engage a salaried staff to carry out urgent work, we inaugurated a campaign to acquire a corporate membership large enough to underwrite the cost. We aimed at a burget of $35,000 a year, which was covered in short order by the very fine response of approximately 300 companies which knew us well and appreciated the importance of the work which we are doing in their behalf. However, without any deliberate attempt on our part to expand beyond the scope of work which we have always recognized as our responsibility the pressure for new investigations and prompt results in the face of higher costs for everything has increased our budget requirements to approximately $50,000. Two alternatives are open to us, namely, to ask our present corporate members to accept a higher annual dues rate or to acquire several hundred additional memberships, and toward this end our

National Committee on Corporate Membership, under the chairmanship of Emmett Driscoll, is initiating a new campaign. Please bear in mind that these funds are needed to underwrite work which we have done for many years but which must now be carried out more intensively at an accelerated rate and at a higher cost. We are not seeking funds to support fantastic ideas nor is it our present aim to engage in fundamental research of an obscure nature.

Of necessity I have gone into some detail on this financial question but the administration feels that it has a tiger by the tail; it is difficult to hold on and out of the question of let go. The work we are doing is not for ourselves; our members derive from it only the benefit of experience and education plus the pleasure of worthwhile accomplishments. As the workshop of the industry in the solving of these community problems and as its mouthpiece for announcing the results, the AATCC feels that it is an integral part of the industry and is entitled to the financial aid which it needs to carry on this task.

In closing I extend to Elmer Smith, as the General Convention Chairman, and through him to all of his commiteemen, and to A. J. Feit, the Chairman of the Mid-West Section, his officers and the entire section, my appreciation for this invitation to address you and for their tireless efforts in making possible this very fine convention. Next year, probably in October, we will meet in the sunny South, as the joint guests of the Southern Sections who will unite for this occasion. Till then —God be with you!

Thank you.

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Joint Committee on Non-Woven Fabrics (ASTM-AATCC)

AT the meeting held in Chicago in October and attended by most of those listed below, Mr. Harvey reported on the results of the first and second questionnaires which indicated the great diversity of testing methods in use by the different laboratories, and hence, the necessity for correlating and standardizing testing methods, as is being undertaken by this Committee.

One of the first problems of this Committee was to outline the scope of our work so it would not conflict with that of the Paper Committees on one hand and the Wool Felt Committees on the other. The question of how to test for Tensile Strength, including machines and atmospheric conditions, was thoroughly discussed and an area of mutual agreement reached. An agreement was also reached on the method to obtain the Weight of Non-Woven Fabrics. Discussions were held on Bursting Strength, Water Absorbency and Water Retention and will be continued, together with the results of a questionnaire on Elongation, Abrasion, Taste and Odors.

Details of the various items taken up at this meeting together with pertinent correspondence will be circulated in the near future merely as a basis for each member's criticism and amendment.

Most of the following were present:—

K. H. Barnard, American Cyanamid Company.

F. H. Hanney, Johnson & Johnson.

J. K. Sumner, Chicopee Mfg. Corp.

G. M. Schroder, Henry H. Frede & Co.

F. H. Osborne, C. H. Dexter & Sons.

H. E. Shearer, American Viscose Corp.

R. J. Oace, Minnesota Mining & Mfg. Co.

H. P. Eichin, The Visking Corporation.

R. R. Stevens, The Felters Company.

D. Y. Miller, The Celanese Corporation.

G. B. Harvey, Draper Corporation.

W. L. Dieroff, Union Wadding Company.

R. J. Spahr, Alternate, Chicopee Mfg. Company.

L. H. Andrews, Alternate, American Viscose Corp.

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Reorganizes Committee on Ageing of Textiles

THE Committee on Ageing of Textiles has recently been reorganized. Members of the Committee are: J. D. Dean, Southern Regional Research Laboratories, Chairman; W. D. Appel, National Bureau of Standards; K. H. Barnard, American Cyanamid Company; W. H. Cady, United States Finishing Company; Mary A. Grimes, Texas Agricultural Experimental Station; Dr. J. F. Oesterling, Philadelphia Quartermaster Depot; Dr. W. M. Scott, Southern Regional Research Laboratories; Col. F. M. Steadman, Philadelphia Quartermaster Depot; and Julian Maas, Cooperating non-member, Brooklyn Naval Clothing Depot.

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Piedmont Sectional Advisory Research Committee

V. B. Holland, of Cannon Mills, has recently been appointed chairman of the Sectional Advisory Research Committee of the Piedmont Section. Other members of the Committee are: Dr. R. E. Rupp, Pacific Mills; Charles E. Ordway, Burlington Mills; Linton C. Reynolds, Riegel Development Laboratories; and Hobart Souther, Proximity Print Works.

Program, NNE Section

AT a meeting of the Sectional Committee of the newly-elected officers of the Northern New England Section, in Boston on December 15, 1947, the following program for 1948 was adopted:

January 23, 1948 at Boston. "An Electrolytic Method for Stripping Wool" by Ernest R. Kaswell, Fabric Research Laboratories, Boston. (The first prize winning paper in Intersectional Prize Paper Contest at the Chicago Convention October 1947).

March 19, 1948 at Boston. "Finishing of Cotton and Rayon Fabrics" by Dr. David X. Klein, Lawrence Print Works, Inc., Division of Aspinook Corp. Lawrence, Mass.

April 16, 1948 at Lowell Textile Institute, Lowell, Mass. by the Student Chapter AATCC.

May 21, 1948 at Andover Country Club, Andover, Mass. "Selection and Application of Dyes on Textiles." A panel of six members qualified to answer questions pertaining to a particular field of dye use or application. This will be a question and answer session.

June 11, 1948. Annual Northern New England Section's Outing.

September 24, 1948 at Andover Country Club. "The A.B.C. of Color and Spectrophotometry" by Norman F. Barnes, General Engineering & Consulting Laboratory, General Electric Company, Schenectady, N. Y.

November 19, 1948. Northern New England Section's Prize Paper presented at the National Convention at Augusta, Georgia in October.

MEMBERSHIP CARDS

Dues payments to the middle of December have been acknowledged with membership cards, and others are being acknowledged within two weeks of their receipt.

If you fail to receive your card, please notify the Secretary, Box 28, Lowell, Mass.

Kindly report address changes also to the Secretary.

Intersectional Contest–

The Effect of Urea on Cellulosic Textiles*

Presented by the
SOUTH CENTRAL SECTION

COMMITTEE

Raymond B. Seymour, *Chairman and Speaker*
Julius A. Crumley
William G. Agnew
Andrew J. Kelley

Abstract

Because of its low cost, solvent power and ability to form complexes with acids and salts with metals, urea has been used commercially in many industries. It is widely used in the textile industry as a dyeing assistant, and as an ingredient in sizes, and in softening and thickening agents.

Cotton may be made flame resistant by treatment with urea and phosphate acid at elevated temperatures. Substitutes for urea in this application are not satisfactory.

The contraction of cotton yarns in caustic is enhanced by urea. Thiourea and dicyandiamide are less effective while compounds such as resorcinol decrease the amount of contraction.

The addition of urea to solutions of cellulose in sodium zincate, viscose, and zinc chloride causes a decrease in viscosity. Similar results are obtainable with thiourea, dicyandiamide and sodium salts of salicylic, acetic and benzene sulfonic acids. Similar results were observed with aqueous solutions of carboxymethyl cellulose, hydroxyethyl cellulose and methyl celulose. Urea exerted little effect on the viscosity of a solution of cellulose in cuprammonium hydroxide, polyvinyl alcohol or starch.

IN spite of the simplicity of its formula and its wide distribution in animals and plants, urea was not discovered until 1773 and not synthesized until fifty-five years late. Its synthesis by Wohler in 1828 was an important milestone in chemistry, since this was the first time that a natural compound had been produced artificially. Thus, it challenged the "vital force" idea and encouraged the synthesis of other organic compounds. Today, over fifty methods for the synthesis of urea are known but only two, the hydrolysis of cyanamide and the reaction of carbon dioxide and ammonia under pressure, are of commercial importance.

Urea is a colorless crystalline solid having a cool saline taste and high solubility in polar solvents. It forms complexes with acids and salts with many metals and is a major industrial chemical. Urea has been used as a brightening agent in silver *(1)* and copper *(2)* plating, deodorant, fertilizer *(3)*, retting agent *(4)*, antiseptic *(5)*, blowing agent in rubber *(6)*, medium for molecular weight determination *(7)* and for the preparation of barbiturates *(8)*, purines *(9)*, plastics *(10, 11)*, water proofing agents *(12)*, dispersing agents *(13)*, moth proofing agents *(14)*, synthetic fibers *(15)*, tanning agents *(16)*, sulfamic acid *(17)* and coating compositions *(18)*.

Large quantities of urea are also used in the production of urea formaldehyde resins. While considerable amounts of these resins are used in the textile industry, this application will be omitted in this discussion.

As previously stated, the discovery of urea is fairly recent, although in the form of human and animal urine it has been used for many centuries. The ancients used urine as a dyeing assistant *(19)*, and in more recent times, it has been claimed that urea exerts a solvent power on dyes to provide deeper shades *(20)*, and that it aids in the fixation of acid dyes on cotton *(21)*. The addition of urea to textile printing pastes is said to improve color fastness *(22)* and to increase color adsorption on rayon fibers *(23)*. Jacoby advocates using six times as much urea as dyestuff and suggests that a swelling action of the cellulose fibers takes place allowing greater dye penetration.

Sizes, finishing, and weighting agents have been prepared from mixtures of urea with saccharoses *(24)*, starch *(25)*, tapioca flour *(26)*, starch in presence of solid weak acids *(27)* and petrolatum in presence of a sulfated stearyl alcohol *(28)*. Thickening agents for printing pastes have been prepared by heating urea and carobbean kernels *(29)* and softening agents for textile fibers have been obtained by the condensation of urea with ethylene diamine *(30)* or methyl cyclohexanol *(31)*.

When added to wood, urea causes swelling of the cellulose fibers *(32)* and wood thus treated becomes thermoplastic when heated *(33, 34, 35)*, and can be kiln dried without checking *(36)*. Cotton fibers have been treated with urea to give properties similar to wool *(37)*.

Flame Proofing

Flame resistant cotton can be obtained by treating cotton with urea and phosphoric acid *(38)*. In this process, urea lowers the surface tension *(39)*, and probably acts as a swelling agent, thus permitting the penetration of the mixture.

Even dilute aqueous solutions of phosphoric acid are detrimental to cellulose but evidently a complex is formed with urea which minimizes the deleterious action. Data presented in Table I and plotted in Figure 1 show that the addition of one mol of urea to one mol of phosphoric acid raised the pH of the solution from 0.70 to 1.18. The addition of 9 more mols of urea to this solution raised the pH to 2.04.

Urea phosphate *(40, 41)* can be readily hydrolyzed but crystallized readily when the hot concentrated solution of urea and phosphoric acid was cooled. When heated above 100° C., urea phosphate evolved ammonia, carbon dioxide and a compound having the empirical formula PO_3NH_4. This compound was presumably H_2NPO_3H and it may be assumed that this phosphamic acid could react with the hydroxyl groups in the cellulose molecule. However, as can be observed from the data in Table I, wash-resistant flame proofness was not

* Presented in Intersectional Contest, Chicago National Convention, October 25, 1947.

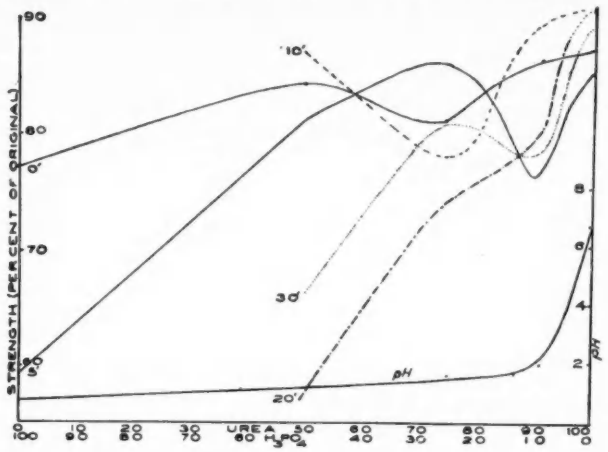

Figure 1. The Effect of Time and Composition of Urea and Phosphoric Acid on Cotton at 100° C.

Table I
The Effect of Time and Composition of Urea and Phosphoric Acid on Cotton at 100° C.

Molar Composition of Solution			pH	Time of heating at 100° C. Min.	Flame Resistance Before Washing	Flame Resistance After Washing	Strength % of Original
H_2O	$(NH_2)_2CO$	H_3PO_4					
20	0	1	0.7	0	10	0	77
				5	10	0	59
				10	10	0	*
				20	10	0	*
				30	10	0	*
30	1	1	1.2	0	10	0	84
				5	10	0	81
				10	10	0	87
				20	10	0	57
				30	10	0	66
55	3	1	1.7	0	10	0	81
				5	10	0	86
				10	10	0	78
				20	10	0	74
				30	10	0	81
80	10	1	2.0	0	10	0	86
				5	10	0	76
				10	10	0	89
				20	10	0	80
				30	10	0	78
12	1	0	6.8	0	7	0	87
				5	7	0	85
				10	2.5	0	91
				20	2.5	0	91
				30	2.5	0	89

NOTE: Flame resistance rated as 10 when treated yarn charred without burning and as 0 when it burned as readily as untreated yarn.
*Sample disintegrated.

obtained when scoured skeins of cotton yarn were treated with mixtures of aqueous solutions of urea and phosphoric acid at 100° C. The degree of flame resistance observed was similar to that obtained from either urea or ammonium salts of phosphoric acid; however, it should be noted that the flame resistance of urea-treated cotton decreases with time when it is heated at 100° C.

In these experiments, scoured skeins of cotton yarn were immersed for two minutes at room temperature in aqueous solutions containing varying properties of urea and **phosphoric acid. The** wet skeins were wrung by hand until the wet pickup was approximately 50%. The yarn was then heated for various intervals in a Dietert dryer and the flame resistance and strength were observed before and after washing in a one per cent solution of Triton 720.

Additional work at higher temperatures using what appeared to be the optimum molar ratio of urea to phosphoric acid; viz., 3:1, showed that permanent flame resistance could be secured at 120° C. only after heating the skeins for forty minutes. Similar results were obtained after twenty minutes at 140° C. or ten minutes at 160° C. However, the strength of the treated yarn was an inverse function of time and temperature. It is worthwhile to note that there was little, if any, increase in weight of the washed treated yarn and the hand was essentially equivalent to that of the original material. This indicates that the flame resistance secured is the result of chemical action and not due to loading the yarn with flame resistant material.

Pertinent data for the experiments at elevated temperatures are given in Table II and the effects of time on flame resistance and strength of cotton yarn are plotted in Figures 2 and 3.

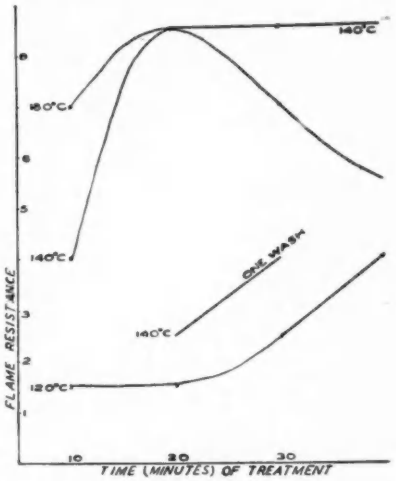

Figure 2. Effect of Time and Temperature on Flame Resistance.

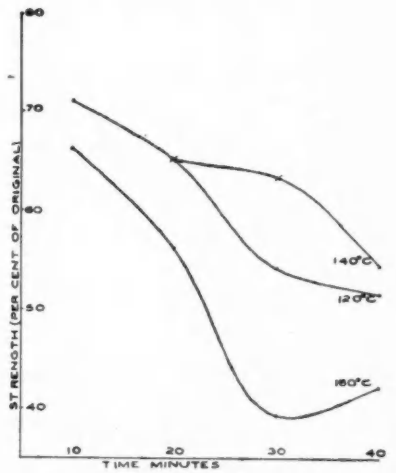

Figure 3. Effect of Time and Temperature of Treatment on Strength.

In these experiments scoured skeins of cotton warn were treated in the manner previously described. The treated yarn was dried for twenty minutes at 100° C. in a Dietert dryer and cured at elevated temperatures in the same apparatus. The skeins were hand washed as in the pre-

Table II
Effect of Time and Temperature on Flame Resistance of Cotton Yarn Treated with Urea (3)—Phosphoric Acid (1)

Curing Conditions			Flame Resistance		
Temp. (°C)	Time (min.)	Strength (%) After Hand Wash	A	1	2
120	10	72	1.5	—	—
	20	65	1.5	—	—
	30	54	2.5	—	—
	40	52	4.0	2.5	0
140	10	72	4.0	—	—
	20	65	8.5	2.5	0
	30	63	8.5	4.0	0
	40	54	8.5	—	—
160	10	66	7.0	2.5	1.5
	20	56	8.5	2.5	2.5
	30	39	7.0	—	—
	40	42	5.5	—	—

A = Hand wash.
1, 2 = Number of washings in mechanical washer.
Note: Flame resistance rated as 10 when treated yarn charred without burning and as 0 when it burned as readily as untreated yarn.

vious experiment then washed twice in a small mechanical washing machine (Handy Hot Electric Washer) for fifteen minutes using 1 oz. soap powder (Super Suds) to three gallons of water.

When thiourea or acetamide was used in place of urea, the yarn disintegrated. When phosphorous acid or ammonium salts of phosphoric acid were used in place of phosphoric acid, slightly inferior results were obtained. Alkyl ammonium phosphates and metaphosphoric acid gave inferior results while trisodium phosphate was ineffective as a permanent flame proofing agent. No advantage was observed when urea phosphate or urea pyrophosphate was used instead of urea and phosphoric acid. The pertinent data obtained are summarized in Table III.

In these experiments scoured skeins were treated in the manner previously described and the dried treated yarn was cured for twenty minutes at 140° C. in a Dietert dryer. The treated skeins were washed as in previous experiment and dried samples were tested for flame resistance by holding samples in a horizontal position over a 2.5 inch bunsen flame.

Mercerization

Katz and Seiberlich *(42)* observed that urea, resorcinol, sodium salicylate, sodium acetate, sodium thiocyanate, thiourea and sodium benzene sulfonate caused swelling of cotton fibers in 25° Bé sodium hydroxide solution. However, X-ray data have not indicated compound formation under these conditions and these compounds were not found to have a uniform effect on the contraction of cotton yarn in aqueous caustic solutions.

The effect of urea and other additives on the mercerization of cotton was investigated using a modification of the technique developed by Landolt *(43)*. A stainless steel bob weighing 1.0 g. was tied to

Table III
Effect on Flame Resistance of Substituting Other Compounds for Urea and Phosphoric Acid

Molar Composition				Flame Resistance			
$(NH_2)_2CO$	H_3PO_4	Other	pH	Strength After Hand Wash (%)	A	1	2
3	1	—	1.5	65	8.5	1.5	0
3	—	$NH_4H_2PO_4$	4.3	65	7.0	2.5	0.5
3	—	$(NH_4)_2HPO_4$	7.4	62	5.5	0.5	0.5
3	—	$(NH_4)_3PO_4$	9.0	70	4.0	0.5	0.5
3	—	Na_3PO_4	11.4	81	0	—	—
3	—	$C_4H_9(NH_4)_2PO_4$	6.4	74	1.5	—	—
3	—	$C_2H_5(NH_4)_2PO_4$	6.0	73	1.5	—	—
3	—	HPO_3	1.5	59	2.5	4.0	0.5
3	—	H_3PO_3	1.3	50	7.0	1.5	0
—	1	$3(NH_2)_2CS$	1.1	*	—	—	—
—	1	$3CH_3CONH_2$	1.3	*	—	—	—

*Disintegrated
A = Samples hand washed.
1, 2 = Number of mechanical washings.

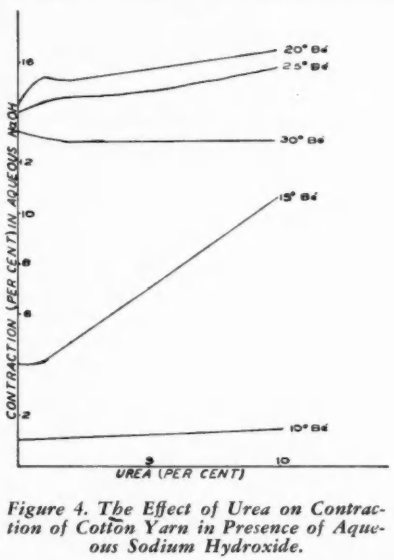

Figure 4. The Effect of Urea on Contraction of Cotton Yarn in Presence of Aqueous Sodium Hydroxide.

Table IV
Effect of Urea on Contraction of Cotton Yarn in Presence of Aqueous Sodium Hydroxide

Concentration of NaOH (°Bé)	Concentration of Urea (%)	Per cent Contraction
10	0	1.0
10	1	1.0
10	5	1.2
10	10	1.4
15	0	4.0
15	1	4.0
15	2	4.4
15	5	7.0
15	10	10.6
20	0	14.2
20	1	15.4
20	2	15.2
20	5	15.6
20	10	16.4
25	0	14.0
25	1	14.4
25	2	14.6
25	5	14.8
25	10	15.7
30	0	13.2
30	1	12.8
30	2	12.8
30	5	12.8
30	10	*

*Urea was not sufficiently soluble and gave off ammonia at room temperature due to the high concentration of caustic.

the end of a 50 cm. length of scoured 40/2 combed peeler cotton yarn which was suspended in a 50 ml. burette containing aqueous sodium hydroxide solution and the contraction of the yarn was observed.

As can be observed in Table IV and Fig. 4, the addition of urea caused an increase in the contraction of cotton yarn in presence of 15 and 20° Bé sodium hydroxide. There was little effect at 30° Bé and the contraction in this concentration of caustic was less than in more dilute solutions. The maximum effect was exerted by small amounts of urea in 20 and 25° Bé caustic solutions. Samples of yarn mercerized in presence of urea were knitted and dyed. The resultant knitted goods were at least as good as those from regular mercerized yarn in respect to lustre, strength, dye affinity and uniformity.

Thiourea and dicyandiamide and possibly melamine were less effective than urea in causing contraction of cotton yarns in aqueous caustic solutions. Sulfamic acid, p-toluene sulfonamide, resorcinol, acetamide, sodium salicylate, sodium

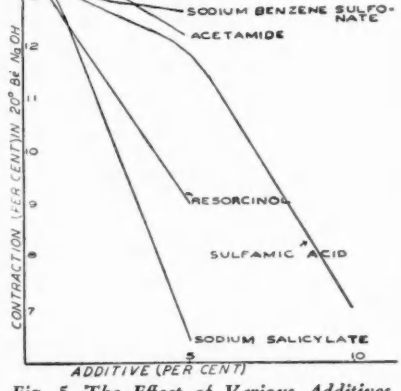

Fig. 5. The Effect of Various Additives on the Contraction of Cotton Yarn in 20° Bé Sodium Hydroxide Solution.

Table V
Effect of Various Additives on the Contraction of Cotton Yarn in 15° Bé Sodium Hydroxide

Additive	Concentration %	Per cent Contraction
None	—	4.0
Thiourea	1	4.0
Thiourea	5	6.4
Thiourea	10	8.8
Dicyandiamide	1	3.4
Dicyandiamide	5	3.8

acetate, sodium thiocynate and sodium benzene sulfonate actually decreased the amount of contraction. These data are summarized in Tables V and VI and Figure 5.

Effect of Urea on Viscosity of Cellulosic Solutions

Alkali soluble products have been obtained by heating cotton linters with urea *(44)*. It has also been found that the gelling of alkaline cellulose solutions could be prevented by the addition of urea and that improved stability could be obtained by the addition of a zincate *(45)*. Mantell *(46)* has studied the effect of the addition of urea to solutions of cellulose in sodium zincate or sodium stannate and has found that the viscosity of these solutions is decreased markedly by the addition of urea. He found that acetamide, ethylene diamine and several other amines were ineffective when substituted for urea and that poor results were obtained when nickel, cobalt, copper and aluminum were used in place of zinc.

Additional work has corroborated Mantell's observations but considerable difficulty was experienced in securing a non-thixotropic solution of cellulose in aqueous sodium zincate. Even after standing eight days at 28-33° C., the solution was slightly thixotropic. Urea had little effect on the viscosity of freshly prepared solutions, but it markedly reduced the viscosity and minimized thixotropy in aged solutions. The viscosity change on aging cellulose solutions without any additive is shown in Figure 6.

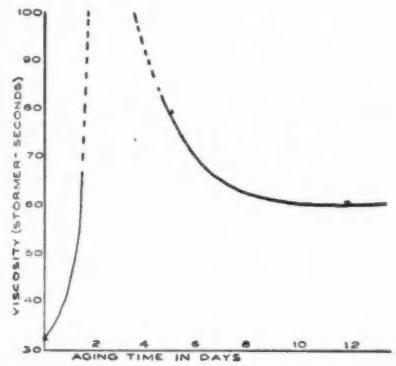

Figure 6. Effect of Aging on Viscosity of Cellulose-Sodium Zincate.

Table VI
Effect of Various Additives on the Contraction of Cotton Yarn in 20° Bé Sodium Hydroxude

Additive	Concentration %	Per Cent Contraction
None	—	14.2
Urea	1	15.4
Urea	5	15.6
Urea	10	16.4
Thiourea	1	14.6
Thiourea	5	15.2
Thiourea	10	15.4
Dicyandiamide	1	14.2
Dicyandiamide	5	15.0
Dicyandiamide	10	15.0
Melamine*	1	14.6
p-Toluene sulfonamide	1	14.2
Sodium thiocyanate	1	13.8
Sodium thiocyanate	5	13.2
Sodium benzene sulfonate	1	13.2
Sodium benzene sulfonate	5	12.6
Acetamide	1	13.8
Acetamide	5	12.2
Sodium salicylate	1	13.2
Sodium salicylate	5	6.4
Sulfamic acid	1	13.2
Sulfamic acid	5	12.0
Sulfamic acid	10	7.0
Resorcinol	1	12.8
Resorcinol	5	9.1

*Not sufficiently soluble for more concentrated solutions.

A 2.5% cellulose solution aged two days which gave Stormer viscosity values ranging from 40 to 124 seconds using a 500 g. load at 21.5° C. gave values ranging from 19 to 22 seconds when 7 g. urea was added and values ranging from 13 to 14 seconds with an additional 4 g. However, after five days, at 28-33° C., the same solution in the absence of urea had decreased in viscosity to a range of 14 to 16 seconds at 20.5° C. The Stormer viscosity values using a 200 g. load at 22° C. ranged from 55 to 62 seconds in the absence of urea, but consistent checks were obtained as soon as 2 g. urea was added to 100 ml. of the cellulose solution. The data summarized in Table VII and plotted in Figure 7 show that there was a marked decrease in viscosity with each addition of urea until a total of 10 g. urea had been added. The decrease in viscosity was less for the next additional 10 g. and but little further decrease was noted after a total of 20 g. had been added.

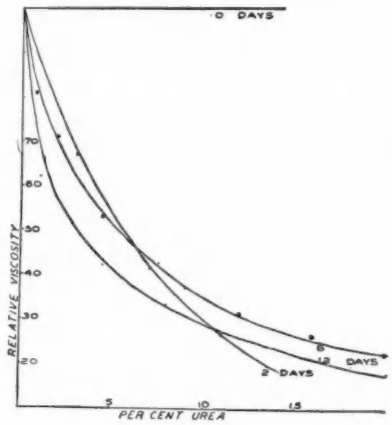

Figure 7. Effect of Urea on Viscosity of Cellulose-Sodium Zincate Solution.

Significant decreases in viscosity of cellulose-sodium zincate solutions aged 12 days were also observed with several other compounds. The data are shown in Table VII and Figure 8. Thiourea behaved like urea but was considerably more effective; sodium sulfamate, sodium benzene sulfamate, sodium benzene sulfonate, sodium salicylate, and sodium thiocyanate were less effective. Resorcinol and sodium acetate were both effective but caused precipitation of cellulose at concentrations of 12 g. and 8 g. per 100 ml. respectively. The cases of melamine and dicyandiamide were interesting in that the viscosity was first depressed and then increased again as more additive was used. The solutions containing melamine were all turbid and interpretation of their behavior would be difficult.

The cellulose-zincate solution for these experiments was prepared by adding 1.5 g. zinc oxide to 12 g. sodium hydroxide in 10 ml. water at 60° C. The solution was cooled, 2.5 g. viscose rayon was added and water was added with stirring to make a total volume of 100 ml. The viscosities were determined using a Stormer viscometer with a 200 or 500 g. load.

Urea is also effective in reducing the viscosity of aqueous solutions of carboxymethyl cellulose, methyl cellulose, hy-

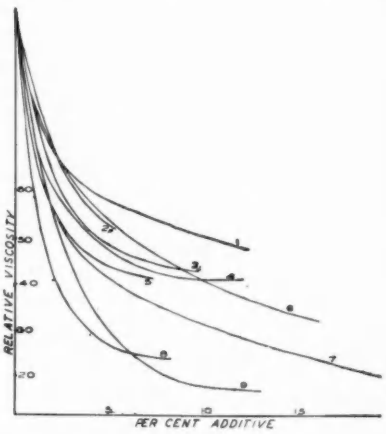

Figure 8. Effect of Some Additives on the Viscosity of Cellulose-Sodium Zincate.
1. Sodium Sulfamate
2. Sodium Acetate
3. Dicyandiamide
4. Sodium Benzene Sulfonate
5. Sodium Salicylate.
6. Sodium Thiocyanate
7. Urea
8. Resorcinol
9. Thiourea

Table VII
The Effect of Additives on Viscosity of Cellulose-Sodium Zincate Solutions

Additive	% Additive	Age of soln. days	Load g.	Temp. °C.	Ave. Viscosity, (sec., Stormer) 0	1	2	3	4	7	8	11	12	16	20	25	
Urea	0	0	200	22	32	—	—	—	—	32	—	32	—	—	—	—	
		2	500	21.5	49	—	—	33	—	20	—	13	—	—	—	—	
		8	200	22	58	47	41	—	31	—	23	—	18	15	13	12	
		12	200	22	60	37	33	—	25	—	20	—	16	13	11	10	
Thiourea		12	200	22	61	41	32	—	20	—	11	—	10	—	—	—	
Dicyandiamide		12	200	22	61	45	37	—	30	—	26	—	29	—	—	—	Turbid at 12%
Melamine		12	200	22	62	55	48	—	53	—	62	—	76	—	—	—	All turbid
Sodium acetate		12	200	22	62	48	43	—	33	—	—	—	—	—	—	—	Gelled at 8%
Sodium salicylate		12	200	22	59	37	31	—	31	—	25	—	25	—	—	—	
Sodium thiocyanate		12	200	22	59	44	39	—	34	—	26	—	21	18	—	—	
Sodium benzenesulfonate		12	200	22	60	40	35	—	33	—	25	—	24	—	—	—	
Sodium sulfamate		12	200	22	57	45	36	—	34	—	30	—	27	—	—	—	Turned green at 8%
Resorcinol		12	200	22	60	35	24	—	17	—	14	—	—	—	—	—	Precipitate at 12%

Table VIII
Effect of Urea on the Viscosity of Aqueous Solutions of Cellulose and Derivatives

Material	(%)	Age of Solution (days)	Urea (%)	Temp. (°C.)	Load (g.)	Viscosity (Sec.)
Carboxymethyl Cellulose	1	0	0	22	154	102
Carboxymethyl Cellulose	1	0	3	22	154	93
Carboxymethyl Cellulose	1	0	7	22	154	82
Carboxymethyl Cellulose	1	0	11	22	154	76
Carboxymethyl Cellulose	1	0	16.5	22	154	68
Carboxymethyl Cellulose	1	0	22	22	154	66
Carboxymethyl Cellulose	3	0	0	21.5	154	76
Carboxymethyl Cellulose	3	0	3	21.5	154	62
Carboxymethyl Cellulose	3	0	7	21.5	154	54
Carboxymethyl Cellulose	3	0	11	21.5	154	43
Carboxymethyl Cellulose	3	0	16	21.5	154	44
Viscose	—	—	0	—	154	87
Viscose	—	—	2.5	—	154	84
Viscose	—	—	5.0	—	154	82
Viscose	—	—	7.5	—	154	77
Viscose	—	—	10.0	—	154	75
Viscose	—	—	15.0	—	154	70
Cellulose R_4N^+,OH^-	5	10	0	22	154	130
Cellulose R_4N^+,OH^-	5	10	1	22	154	125
Cellulose R_4N^+,OH^-	5	10	2	22	154	121
Cellulose R_4N^+,OH^-	5	10	8	22	154	100
Cellulose R_4N^+,OH^-	5	10	12	22	154	89
Cellulose R_4N^+,OH^-	5	10	16	22	154	83
Cellulose in $ZnCl_2$	1.25	0	0	21	100	32
Cellulose in $ZnCl_2$	1.25	0	1	21	100	27
Cellulose in $ZnCl_2$	1.25	0	2	21	100	27
Cellulose in $ZnCl_2$	1.25	0	5	21	100	25
Cellulose in $ZnCl_2$	1.25	0	10	21	100	24
Polyvinyl Alcohol	2	0	0	20	26.9	22
Polyvinyl Alcohol	2	0	2.5	20	26.9	22
Polyvinyl Alcohol	2	0	5	20	26.9	22
Polyvinyl Alcohol	2	0	7.5	20	26.9	22
Polyvinyl Alcohol	2	0	10	20	26.9	22
Polyvinyl Alcohol	2	0	15	20	26.9	22
Methylcellulose (25 cps.)	2	0	0	21.5	154	10.3
Methylcellulose (25 cps.)	2	0	3	21.5	154	10.0
Methylcellulose (25 cps.)	2	0	7	21.5	154	9.9
Methylcellulose (25 cps.)	2	0	11	21.5	154	9.6
Methylcellulose (400 cps.)	2	0	0	22	154	65.3
Methylcellulose (400 cps.)	2	0	3	22	154	58.8
Methylcellulose (400 cps.)	2	0	7	22	154	54.4
Methylcellulose (400 cps.)	2	0	11	22	154	49.7
Methylcellulose (400 cps.)	2	0	15	22	154	43.6
Hydroxyethyl Cellulose	6	0	0	22	500	256
Hydroxyethyl Cellulose	6	0	2	22	500	244
Hydroxyethyl Cellulose	6	0	4	22	500	227
Hydroxyethyl Cellulose	6	0	8	22	500	199
Hydroxyethyl Cellulose	6	0	16	22	500	156
Cellulose in $Cu(NH_3)_4(OH)_2$	2	0	0	20	26.9	36
Cellulose in $Cu(NH_3)_4(OH)_2$	2	0	2.5	20	26.9	36
Cellulose in $Cu(NH_3)_4(OH)_2$	2	0	5	20	26.9	36
Cellulose in $Cu(NH_3)_4(OH)_2$	2	0	10	20	26.9	36
Cellulose in $Cu(NH_3)_4(OH)_2$	2	0	15	20	26.9	36

droxyethyl cellulose, cellulose xanthate and solutions of cellulose in trimethyl benzyl ammonium hydroxide. The viscosities of solutions of cellulose in zinc chloride were also reduced by the addition of urea but the results were not consistent. No significant reduction in viscosity was noted when urea was added to aqueous solutions of polyvinyl alcohol, starch or cellulose in ammoniacal copper hydrox-

Figure 9. The Effect of Urea on the Viscosity of Aqueous Solutions of Cellulose and Derivatives.

ide. Facilities were not available for spinning these solutions under mill conditions but all solutions containing urea were more stable than the regular solutions; filaments were obtained with ease and these solutions appeared to cause less clogging of the spinnerets.

These data are summarized in Table VIII and Figure 9.

The solutions were prepared as follows:

Corboxymethyl cellulose: 1 g. Carboxymethocel S, high viscosity was dissolved with stirring in 100 ml. distilled water.

Methylcellulose: 2 g. Methocel (400 cps.) and (25 cps.) were each dissolved with stirring in 100 ml. distilled water.

Hydroxyethyl cellulose: 6 g. high viscosity Ceglin was stirred with 78 ml. ice water and 16 ml. 50% aqueous sodium hydroxide was added and the solution was stirred until the solid was completely dissolved.

Cellulose Xanthate: 100 ml. water was added to 100 g. viscose solution having a viscosity of 47 centapoises.

A solution of cellulose in trimethylbenzyl ammonium hydroxide was prepared by adding 5 g. viscose rayon to 40 g. Triton B in 100 ml. water and adding 5 g. sodium hydroxide with stirring to the partly dissolved solution.

A solution of cellulose in aqueous zinc chloride was prepared by adding 1.25 g. viscose rayon to a concentrated aqueous solution containing 81 g. zinc chloride and making up to 100 ml.

A solution of polyvinyl alcohol was prepared by dissolving 2 g. Elvanol with stirring in 100 ml. of water.

A solution of cellulose in ammoniacal copper hydroxide was operated by adding 2 g. viscose rayon with stirring to the cold solution obtained by adding 44 ml. cold concentrated aqueous ammonia to a cold solution of 4.82 copper sulfate in 20 ml. water and then adding 20 ml. cold 12% aqueous sodium hydroxide solution.

Conclusion

In this investigation a survey has been

made of the many uses of urea with particular emphasis on its application in the textile industry. No claim is made for the originality of work previously done and referred to in the bibliography. However, while general statements have been made on the use of urea and phosphoric acid for flameproofing of cotton, no details have been published nor has there been any mention in the literature of the mechanism, optimum conditions or the effect of related compounds. The effect of urea and related compounds on the contraction of cellulosic yarns in aqueous caustic has not been previously reported. Mantell has shown that urea would cause a decrease in the viscosity of cellulose solutions in aqueous sodium zincate but he was unable to find other compounds that exerted a similar effect. No previous reference has been found on the effect of urea on the viscosity of other aqueous solutions of cellulose or cellulose derivatives.

The compilation of the major industrial uses of urea is of scientific value in itself, but it is of course of much less importance than actual discoveries which have been made in this investigation.

The practical value of any investigation on the flameproofing of cotton is recognized even by the layman as a result of recent catastrophes and pending legislation. The data on the effect of additives which regulate the contraction of cotton yarns immersed in aqueous caustic solutions will be of great practical value to the mercerizing industry. It would be redundant to state that workers in the coating, fiber and film industries using aqueous solutions of cellulose or its derivatives will readily realize the practical importance of data on additives which regulate viscosity, minimize thixotropy and stabilize cellulosic solution.

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We wish to express our appreciation to E. L. Powell of the Southern Chemical Cotton Company for supplying viscose solutions, to George M. Schroder of the Henry H. Frede Company for samples of viscose rayon and to William G. Agnew of the Dixie Mercerizing Company and the following members of the staff of the Industrial Research Institute of the University of Chattanooga for supplying data for this paper:

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O. G. Edwards
F. W. Harris
J. W. LeMaistre
W. F. Luther
G. B. Magin.

Source of Materials

The materials used were obtained from the following sources:

Urea, Commercial product, E. I. du Pont de Nemours and Company.

Phosphoric acid, 85% technical grade, J. T. Baker and Company.

Triton 720, Rohm and Haas Company.

Super Suds, Colgate-Palmolive-Peet.

Urea phosphate, Monsanto Chemical Company.

Urea pyrophosphate, Monsanto Chemical Company.

Mono-ammonium phosphate, Monsanto Chemical Company.

Di-ammonium phosphate, Monsanto Chemical Company.

Tri-ammonium phosphate, Monsanto Chemical Company.

Trisodium phosphate, Baker and Adamson.

Butyl diammonium phosphate, Victor Chemical Company.

Ethyl diammonium phosphate, Monsanto Chemical Company.

Meta phosphoric acid, J. T. Baker Chemical Company.

Phosphorous acid, J. T. Baker Chemical Company.

Thiourea, Eastman Kodak Company.

Sodium hydroxide, J. T. Baker Chemical Company.

Dicyandiamide, American Cyanamid Corporation.

Melamine, Eastman Kodak Company.

Sulfamic acid, E. I. du Pont de Nemours and Company.

p-Toluene sulfonamide, Eastman Kodak Company.

Resorcinol, Eastman Kodak Company.

Acetamide, Eastman Kodak Company.

Sodium salicylate, General Chemical Company.

Sodium benzene sulfonate, General Chemical Company.

Sodium thiocyanate, Baker and Adamson.

Rayon, tire cord type, Industrial Rayon Corporation.

Zinc oxide, General Chemical Company.

Carboxymethyl cellulose (Carboxymethocel S), Dow Chemical Company.

Hydroxyethyl cellulose (Ceglin), Sylvania Corporation.

Methyl cellulose (Methocel), Dow Chemical Company.

Zinc chloride, Merck and Company.

Triton B, Rohm and Haas Corporation.

Viscose, this solution was made experimentally by the Southern Chemical Cotton Company from purified cotton linters.

Polyvinyl alcohol, Elvanol, E. I. du Pont de Nemours and Company.

Copper sulfate, J. T. Baker Chemical Company.

Ammonia, E. I. du Pont de Nemours and Company.

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Notice to Local Section Secretaries:

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Finishing and Auxiliaries Group Meeting—

Permanent Finishes on Rayon*

LEONARD SHAPIRO
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Introduction

INTEREST in durability of textile finishes has been increasing steadily during the past 25 years. The earlier development of dyestuffs fast to light and washing has been a fore-runner of this trend. Naphthol, sulfur and vat dyestuffs have become increasingly important in the production of washable textiles.

The outstanding success of the dyestuff industry, however, has served to accentuate the inadequacies of many of our finishing methods. Today, in order for a garment to be considered *"fully-washable"* it is not enough for the dyestuff alone to withstand laundering or dry cleaning. It is of particular importance that the *dimensions* of the garment should not change during these operations, since this would render the garment unwearable even though the dyeing is unaffected. On the other hand, it would be misleading to advertise a garment as *"fully-washable"* if it retains its original dimensions, but the color does not remain fast.

Thus, the two most important attributes of "fully-washable" textiles, *colorfastness* and *dimensional stability*, go hand in hand. As soon as one of them is improved, there is an immediate demand for corresponding improvement in the other.

Other finishes which are used for special effects on washable fabrics should also be fast to laundering but less attention has been paid to them in the past because loss of these properties usually does not make the garment unwearable. Most important of these special finishes are: sizing agents, softeners and water-repellents. More or less permanent finishes of these types are already in use.

Other, more specialized finishes, whose permanence has recently been improved are the various "proofing" treatments for imparting mildew-resistance, flame-resistance, moth-resistance, fume-resistance and crease-resistance. Permanent mechanical effects such as embossing, moiré, and plissé effects are also in demand.

*Presented at Finishing and Auxiliaries Group Meeting, C. W. Wille, presiding, National Convention, Chicago, October 24, 1947.

The recent war furnished a great impetus for the development of all the above types of permanent finishes. Obviously, the quartermasters of all nations were interested in seeing that difficult-to-replace textile materials remained usable as long as possible. There was also an increase in the demand for "multiple-function" fabrics which show simultaneous durable resistance to several different destructive agents. Most notable of these was the flame-resistant, water-repellent, mildew-resistant tent duck used by the Army in such tremendous quantities.

It is natural that washable finishes should have found earliest application to cotton, since cotton is considered relatively stable, and, once compressive pre-shrinkage machinery became available, the way was paved for washable dyes and finishes.

Until recently, rayon has been considered as "inherently unstable" in dimensions, and consumers were afraid to wash rayon garments or to send them to the laundry. Since it was expected that all rayon garments would be dry-cleaned, dyes and finishes did not have to be fast to washing, but only to drycleaning (a much less rigorous specification). Hence the use of direct dyes and water-soluble finishes is still common practice on many types of rayon fabrics.

More recently the rayon manufacturers and the more skillful rayon finishers have demonstrated that, with proper manufacturing control, they can produce rayon fabrics which are "fully-washable." First, it was found that a few types of rayon-cotton mixture fabrics could be finished to give reasonable dimensional stability by compressive shrinkage alone, and some could be stabilized by means of resin or chemical treatments, sometimes in combination with compressive shrinkage methods.

The limited wash-resistance of some of these shrinkage-control methods has been overcome during the past year by the increasing usage of two new techniques based on caustic-swelling methods and aldehyde treatments. Since both of these treatments are permanent and last as long as the fabric, the demand for more permanent dyes and finishes has been greatly stimulated, and millions of yards of fully-washable rayons have been manufactured into garments.

I. Shrinkage Control Processes

Causes of Shrinkage—The so-called "inherent instability" of rayon is due largely to the fact that rayon has a lower modulus of elasticity than the more highly crystalline natural cellulose fibers, and, hence is more readily stretched in handling. This is particularly true of regenerated cellulose rayon when wet, since it swells much more than cotton and in this more plastic state is readily deformed by slight applications of force. When the rayon is dried in this stretched condition, the strains are temporarily "set" at the dried dimensions. If the material is subsequently wet out and then dried without tension, these strains are relaxed and the yarn or fabric shrinks until it approaches its original unstretched length.

The introduction of internal strains in rayon yarns can begin during the manufacture of the yarn itself and would occur whenever the yarn is removed from an aqueous treating bath under tension. The amount of stretch will depend, to a large extent, on the manufacturing process employed. Skein dyers are well aware of the fact that the shrinkage of the yarns they receive from different sources varies considerably, and in some cases, the skeins must be pre-shrunk to avoid excessive tension during dyeing.

The next important point at which strains are introduced into the rayon yarn is during spinning and weaving. Tensions during spinning, warping, and on the loom itself undoubtedly contribute to some extent; however, the slashing operation, a wet-processing step, is probably the principal offender. The yarns are held under considerable tension during immersion in the hot sizing bath as well as during the drying operation.

If the fabric is scoured, dyed and finished under relaxed conditions, these accumulated strains will relax and shrink-

age will take place. Some rayon grey goods shrink as much as 25% in length during normal scouring operations at the finishing plant.

Cellulose acetate fibers do not swell as much in water as regenerated cellulose fibers, and many acetate fabrics show little laundering shrinkage. Nevertheless, certain filament-acetate-warp grey fabrics show warp shrinkages of more than 20%, and it is no easy matter to stabilize such fabrics during the subsequent finishing operations.

Preshrinkage—Obviously, if all the tensions which occur in the manufacture of the yarn and fabric could be eliminated, and if the finisher could dye and finish with absolutely no tension, a strain-free fabric could be produced.

While this may appear simple to the uninitiated, the accomplishment of this ideal condition is neither practical nor necessarily desirable. The elastic properties of rayon yarns are greatly improved by the application of a certain amount of stretch during processing. If a rayon fabric which showed 25% laundering shrinkage in the grey were completely relaxed and shrunk 25% by the finisher, the warp would show excessive crimp and stretchability. A garment made of such a "preshrunk" fabric would not shrink further, but might be easily distorted during cutting up and sewing or in subsequent laundering, drying and ironing.

For these reasons, processes which "stabilize" the yarns with a minimum of preshrinkage are preferable. On the other hand, many rayon fabrics require a shrinkage of about 10% in order to close up the weave structure or to obtain the desired fabric construction or appearance. If such fabrics were stabilized without preshrinkage, they might appear "thin," "open" or "flat." Hence, the balance between processing *"pre-shrinkage"* and *"stabilization"* is usually a compromise which varies with the requirements of each particular fabric.

"Preshinkage" is obtained either by boiling-off and drying with minimum warp tension or by adjusting to final dimensions on a compressive shrinkage machine or overfed tenter. In the case of most rayon fabrics, preshrinkage alone is not sufficient, and one of the *stabilization* methods must be employed also.

Resin Stabilization Methods—Stabilization of rayon fabrics by means of resins has been fairly successful on certain fabric constructions. The stabilizing effect is due to the deposition of an insoluble resin in and around the fibers. This forms a three-dimensional structure within the fibers which inhibits the relaxation of internal strains that would otherwise occur on laundering.

Water-soluble urea-formaldehyde *(1)* and melamine-formaldehyde condensates, and their methyl ethers, are most frequently used for this purpose. These are applied from water solution, together with an acidic or potentially acidic catalyst, dried and cured by baking at elevated temperatures. They are then neutralized, rinsed, and framed to predetermined width.

Because of the fact that the resin processes depend on the presence of an insoluble material in the fiber structure, their washfastness is limited by the ability of the resin to withstand leaching-out by repeated severe launderings.

One objection to the nitrogen-containing resins is the fact that they combine with the chlorine used in laundering and form compounds which do not rinse out of the fabric. When the fabric is later ironed or hot-pressed, free chlorine or hydrochloric acid is released, and considerable damage to the fabric results.

In resistance to both laundering and chlorine-retention, the melamine resins are somewhat superior to the urea-formaldehyde resins. The ketone-aldehyde resins, which are now being used to some extent, have the interesting property of curing with an *alkaline* catlyst and of exhibiting no chlorine-retention.

An interesting application for resin finishes is in the production of durable mechanical effects on fabrics. Best known is permanent glazed chintz which is produced by applying a resin- containing material to the fabric, drying, then calendering to a high finish and curing the resin. The glazed effect is not removed by subsequent washing *(2)*.

Durable embossing effects can likewise be produced by drying the resins on the fabric, embossing, and then curing.

Stabilization With Caustic Alkali: Many attempts have been made in the past to "mercerize" rayon, and this operation has generally resulted in parchmentizing, stiffening, or harshness of hand. It has recently been discovered that by proper control of temperatures, concentrations, and mechanical factors, rayon fabrics may be stabilized against further laundering shrinkage without damage to the fabric *(3)*.

This stabilization is accomplished without deposition of insoluble materials on the fibers and without chemical alteration of the cellulose. The only change in the fiber appears to be physical in nature, and just why stabilization is produced by this method is not completely understood. According to one theory, the controlled swelling and plasticizing action of concentrated alkali-solutions permits the molecules to become re-oriented to a strain-free configuration and, hence, further changes in the dimensions will not occur. Another theory is that the "crimp" of the yarns is "set" by the stabilization process, and this prevents further dimensional change.

The caustic process is applied on a continuous range consisting of a padder, a skying unit and a series of open-width wash boxes all synchronized for continuous tensionless operation (Fig. 1).

The caustic treatment may be carried out on the grey goods or after scouring or dyeing.

In one simple method of application, the fabric is scoured, vat dyed and dried first. It is then padded with minimum tension through a 40% caustic soda solution containing penetrants and protective colloids which permit uniform action of the alkali while protecting the fabric from deterioration.

The fabric is skyed about 15 seconds to allow time for action on the cellulose and then is neutralized quickly by immersing in dilute sulfuric acid in the first compartment. (Rapid, complete neutralization is essential).

The fabric is rinsed in water, and the last traces of acid are removed in a sodium bicarbonate bath. The fabric is rinsed and boiled-off in a beck under relaxed conditions, then rinsed, opened, extracted and dried on a loop drier.

A wash test is performed at this point to determine the finished width and the fabric is steam-framed. Minimum warp tension is maintained in all finishing, calendering or decatizing operations particularly when the fabric is wet to prevent the introduction of strains which might result in loss of stabilization.

At caustic soda temperatures below 100° F., acetate-warp fabrics can be stabilized without saponification, and blends containing wool may be stabilized without loss in wool content.

This method of stabilization has advantages in ease of operation, applicability to a wide range of fabric types and on fiber mixtures containing cotton, acetate, wool and Aralac. It has no effect on hand, tensile strength, or abrasion-resistance and does not cause chlorine-retention. When applied before dyeing, the dyeing or printing qualities are frequently improved, especially on mixed-fiber fabrics *(4, 5, 6)*.

The fact that more concentrated caustic solutions and higher temperatures cause less damage to rayon may be surprising to those not familiar with the art. Fig. 2 shows the manner in which the solubility of modified cellulose varies with temperature and caustic concentration *(13)*. At low temperatures, rayon solubility is at a maximum between 8% and 12% caustic (as temperature decreases, the maximum shifts toward the lower concentration).

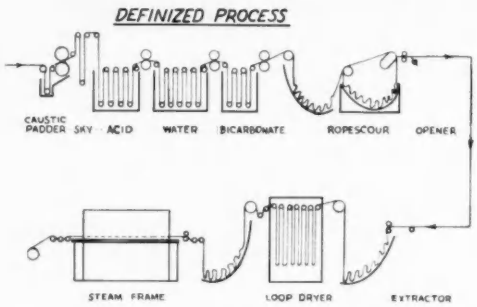

Fig. 1. Flowsheet—Caustic Stabilization Process.

Fig. 2. Solubility of Modified Cellulose in Caustic Soda.

ALDEHYDE-CELLULOSE COMPOUNDS

Acetal Formation:

$$HCHO + 2\,ROH \xrightarrow{H^+} H_2C\langle^{OR}_{OR} + H_2O$$

Formaldehyde

$$\begin{matrix}CHO\\CHO\end{matrix} + 4\,ROH \xrightarrow{H^+} \begin{matrix}RO\\RO\end{matrix}\!\!>\!CH\text{-}CH\!<\!\begin{matrix}OR\\OR\end{matrix} + 2\,H_2O$$

Glyoxal

Hemi-acetals:

$$HCHO + ROH \xrightarrow{H^+} H_2C\langle^{OH}_{OR}$$

$$\begin{matrix}CHO\\CHO\end{matrix} + 2\,ROH \xrightarrow{H^+} \begin{matrix}HO\\RO\end{matrix}\!\!>\!CH\text{-}CH\!<\!\begin{matrix}OH\\OR\end{matrix}$$

Fig. 3. Reactions of Cellulose with Aldehyde. (ROH = Alcohol or Cellulose)

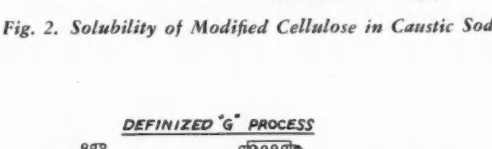

Fig. 4. Flowsheet—Glyoxal Stabilization Process.

At —5° to —10° C, solubility is almost complete.

The degree of stabilization obtained in commercial scale operations on a variety of fabrics is illustrated in Table 1.

The effect of accelerated tests designed to show the effect of chlorine retention in laundering are illustrated in Table 2. The great advantage of this stabilization method over chlorine-retentive resins is obvious.

Aldehyde Stabilization Methods: The cellulose molecule contains three free hydroxyl groups per C_6 unit. These hydroxyl groups can form acetals when reacted with aldehydes in the presence of acid catalysts: HCHO + 2 ROH = $H_2C(OR)_2$ + H_2O (Fig. 3). Since one aldehyde molecule reacts with two hydroxyl groups, cross-linkages are readily formed between adjacent cellulose chains.

This acetal formation has two effects: first, the cross-linkages between the molecules "set" the dimensions, preventing further shrinkage. Second, the blocking of hydroxyl groups decreases the swelling of the fiber by water, and further reduces the possibility of readjustment of internal strains by fiber shrinkage.

The reaction of formaldehyde with cellulose has been known for many years, but it has never been used to any great extent because of difficulty in controlling the reaction and because of the damage caused by the acid catalysts employed.

The recent commercial production of *glyoxal*, a di-aldehyde of low volatility, has finally paved the way for the development of practical aldehyde processes. Improvements have recently been made by modification of the catalyst so as to obtain stabilization without appreciable change in tensile strength, even on 100% cotton fabrics *(3)*.

This process is applied on the dyed fabric by padding with a 2% to 5% solution of glyoxal (about 7% to 15% of commercial 30% glyoxal) containing the required amounts of acidic catalysts and modifiers. The cloth is framed and barely dried. It is then baked at elevated temperatures, slack-washed, dried, and framed to predetermined dimensions (Fig. 4).

The principal disadvantage of this process, as compared with the caustic soda process, is that it requires additional drying and curing operations, thereby increas-

Table 1—Typical Laundering Tests—Caustic Process

Fabric	No. of washes	Stabilized warp	Stabilized fill	Untreated warp	Untreated fill
Tackle Twin, 8 oz.	1	0%	0.6%	12.7%	1.1%
(Filament rayon warp)	5	0	0.6	13.8	1.7
Acetate Warp Poplin	1	2.1	0.2	21.7	2.8
100 x 54	5	3.0	0.7	21.2	3.0
17% Wool Suiting	1	1.7	0.2	14.2	2.3
	5	2.3	+0.2	17.3	2.7
40% Wool Gabardine	1	1.3	1.4	...	..
	5	1.5	0.7	...	..

Table 2—Effect of Chlorine Retention

	Original Strength	Chlorine-Treated 1 wash	Chlorine-Treated 5 washes
Stabilized—Caustic Method	42 lbs.	42 lbs.	40 lbs.
Resin-treated	46 lbs.	5 lbs.	7 lbs.

ing the cost of handling and overburdening the finisher's drying facilities (which in many plants are already a bottleneck). Since chemical modification of the cellulose affects its dyeing properties, it is necessary to apply the process *after* dyeing. Wool fibers are badly discolored by glyoxal, and hence the process is not used for rayon-wool mixtures (as is the caustic process). Acetate fibers already have two-thirds of their hydroxyl groups blocked, and hence are not as susceptible to stabilization by this method.

The glyoxal process does not affect the hand of the fabrics, and it is frequently necessary to apply sizing agents to obtain a firmer or fuller hand. If starch, dextrine, polyvinyl alcohol or soluble celluose derivatives are mixed with the glyoxal padding liquor, they will react with the glyoxal on baking and form a permanent finish that will not wash out of the goods. Because of the cross-linking effect of the aldehyde, very small amounts of polyvinyl alcohol, for example, will produce a marked stiffening effect.

Of especial importance is the fact that, by proper adjustment of catalysts and time and temperature of baking, even *all-cotton* fabrics can be stabilized at greater yardage and width than would be obtained by compressive shrinkage methods. When polymers containing hydroxyl groups are added to the glyoxal solution, an outstanding permanent finish is also obtained. In addition to being shrinkage-controlled, the cloth has a fuller hand and does not fuzz-up on laundering. The combination of catalysts with retarding and protective agents *(3)* is the key point in production of such cotton fabrics.

II. Crush-Resistant Finishes

Crush-resistant finishes depend on the formation of an insoluble resin polymer within the rayon fiber. For this purpose, monomeric urea-formaldehyde condensates or melamine formaldehyde condensates are employed. Concentrations are about twice as great as required for shrinkage-control. If the fabric is finished at predetermined dimensions, shrink-resistance and crush-resistance may be obtained simultaneously.

Chlorine-retention is likely to be a serious factor in crush-resistant finishes. Up to the present time only urea-formaldehye and melamine-formaldehyde condensates have been found commercially suitable for imparting crush-resistance, and we must continue to put up with some chlorine-retention.

While the aldehyde-treatments used for stabilization produce some degree of crushproofing, the quantities required have proven impractical. A combination of resin and aldehyde may be used to obtain both crush-resistance and shrinkage-control. In this case, some chlorine-retention results, but much less resin is used than would be required for a resin finish alone.

In the past, the production of crush-resistant finishes on *cotton* has not been very successful—not only because of chlorine-retention, but also because of excessive loss in tensile strength.

Recently, however, some cotton fabrics have been successfully treated for crush-proofing with a newly developed melamine resin. A process has also been developed for curing cotton fabrics treated with conventional type resins in a steam atmosphere. When the proper catalysts are employed, no loss in tensile strength occurs *(3)*.

III. Thermoplastic Resin Dispersions

Since "fully washable" fabrics require finishes which resist removal by laundering or dry cleaning, the older starch type finishes are no longer adequate. Permanent sizing is now obtained by the use of thermoplastic resins, which are most easily applied in the form of a water-dispersion. The operation is quite simple and consists in merely applying the required amount of resin (usually 1% to 5% resin solids) to the fabric and drying at 240° to 300° F. A temperature of 280° F. to 300° F. is preferred in order to fuse the resin into a film surrounding the fibers. On bright rayon many of these resin emulsions have a delustering effect which resists laundering and dry cleaning.

The resin emulsions which find the greatest application to rayons are vinyl, acrylic, and styrene polymers and copolymers. For all-round utility and low cost, the vinyl resins are useful. Acrylic resins are used where absolute clarity, whiteness, and freedom from discoloration by heat and light are required (1). Styrene, because of difficulties in plasticizing, is used principally in copolymers.

The principal uses of these emulsions are:

1) General sizing agent to obtain a stiffer or fuller hand.
2) Snag-resistant finish for hosiery.
3) Durable delusterant and slip-resistant finish.
4) Backing for carpets and rugs.
5) To improve pigment binding in filling and weighting mixtures.

Shrinkage-control and crush-resistance are not generally obtained by the use of thermoplastic resin dispersions.

The finish obtained by the use of these dispersions resists removal by laundering, dry-cleaning, acids and alkalis. Abrasion-resistance is improved, and there is no loss in tensile strength.

The resin dispersions are sensitive to freezing, and some care should be used to see that the bath conditions do not cause precipitation and to avoid build-up on rollers.

Each type of resin dispersion is available in a hard and soft (plasticized) finish. Intermediate degrees of softness are obtained by blending the hard and soft resins together.

For backfilling, the resin dispersion is thickened with a colloidal thickening agent (gum, starch, or soluble cellulose derivative) and talc or clay is added. The ratio of fillers to film-forming material may be 1:1 to 2:1.

IV. Cellulosic Compounds

Alkali-soluble celluloses of the hydroxyethyl celluose type and the degraded celulose type have been in use as permanent sizing and binding agents. They are especially valuable as permanent sizing agents for sheeting and shirting fabrics, and were used during the war to a great extent on mosquito and camouflage nettings.

A similar effect is obtained by application of viscose solution to the cloth followed by regeneration of the cellulose on the fabrics *(7)*.

Alkali-soluble celluloses are also useful as binding agents for vat-dyeing by the pigment-pad method or for indigosol dyeing.

V. Durable Water-Repellents

Wax-Zirconium Compounds: The wax-alumina compounds, so widely used in the past, do not resist either washing or dry-cleaning. More recently, zirconium compounds have been used in place of aluminum compounds to obtain a semi-durable finish. The wax-zirconium finishes are quite resistant to dry-cleaning and somewhat more resistant to laundering than the wax-alumina compounds. They are available as one-component or two-component products which are applied from a single bath and dried at a temperature which fuses the waxes.

Durable Water-Repellents: The "durable" type water-repellents consist of a long-chain fatty radicle attached to a reactive end-group capable of combining with the hydroxyl groups of the cellulose molecule. Fatty acid chlorides, aldehydes, anhydrides, and chloromethyl compounds are examples of the more important types which, at elevated temperatures, can form cellulose ethers and esters.

All the compounds listed above are insoluble in water and must be applied from solvent solution. Since solvent ap-

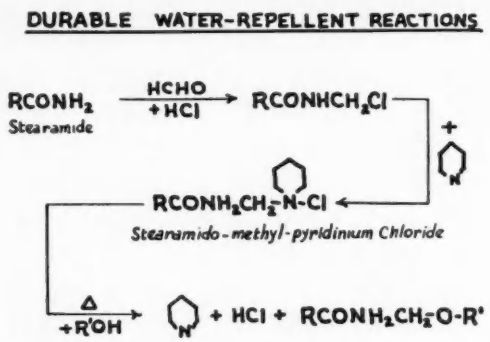

Figure 5. Durable Water-Repellent Reactions. Synthesis and Reaction with Cellulose (R'OH).

plications are not very popular among textile finishers, their utility is limited to those compounds which can be combined with a solubilizing group that splits off at elevated temperatures.

Perhaps the best-known of these durable water-repellents is chloromethyl stearamide quaternized with pyridine (Fig. 5). The quaternary compound is readily dispersible in warm water. Sodium acetate buffer (equal to about one-fifth the weight of water-repellent) is added. The resultant solution is stable for ½ to 1 day under conditions of operation.

Generally, about 5% of active water-repellent on the fabric together with 1% of sodium acetate produces satisfactory results. The solution is padded onto the fabric (thorough saturation is important) which is dried and then baked at 275° to 400° F. for a period of time varying between 5 minutes and ½ minute, depending on the temperature and type of fabric.

During the baking or curing operation, three different reactions take place. First, the pyridine is split off liberating the chloromethyl compound; second, the chloromethyl compound so liberated combines with the cellulose, splitting off hydrochoric acid; third, the hydrochloric acid, as rapidly as it is formed, combines with the sodium acetate, forming sodium chloride and liberating acetic acid. This prevents damage to the fabric by the hydrochloric acid.

The fabric is finally neutralized in a bath containing soda ash and a detergent and then dried at elevated temperature.

In addition to the amido-methylene type compound described above, another durable water-repellent which has been out standing for its uses on army clothing fabrics during the war, and is now well-known in the civilian rainwear market *(8)*, is the complex reaction mixture of a high-molecular-weight nitrile with formaldehyde, a high-molecular-weight acid-chloride and a tertiary amine *(9)*. The reactions during baking are similar to those described for the amide compound above.

Both these types of water-repellents resist removal during laundering or dry-cleaning.

Other durable-water-repellents, based on paraffin or high-melting synthetic waxes combined with resins produce interesting results, but have not yet become important in commercial production.

VI. Softeners

The so-called "substantive softeners" have much greater durability than the older sulfonated and saponified oils and fats *(14)*.

There are several types of substantive softeners. Perhaps the most commonly used are the hydroxy-alkylated amide types. When dissolved on the acid side, they form *cationic* compounds. On the alkaline side they form *anionic* substantive softeners which are more compatible with conventional type finishing ingredients. A nearly neutral series of compounds with similar properties is the alkyl guanidine type.

The true *quaternary* compounds are somewhat more expensive, but show greater substantivity. The quaternary compounds are stable in acid, neutral and alkaline solutions. Some of them have the interesting property of preventing bleeding of direct or developed dyeings in water. On the other hand they generally alter the shade and lightfastness of dyeings to a greater degree than the amide types.

It is interesting to note that some substantive softeners will cause chlorine-retention. For this reason, softeners should be selected with care if maximum chlorine-resistance is desired.

VII. Flameproofing Compounds

A number of effective durable flameproofing compounds have been developed in the last ten years, and these are generally based on organic solutions of resins (or water emulsions of these resins) containing chlorinated compounds, and fire-retarding pigments such as stannic oxide, antimony oxide, zinc borate, etc.) *(10)*. The pickup required to impart flame-resistance is generally about 40% of the weight of the fabric. For certain purposes, the weighting and the coated fabric effect obtained are an asset (draperies, etc.). For light-weight clothing, however, the effect on the hand of the fabric is undesirable.

The two-bath methods, based on precipitation of stannic oxide on the fabric require a little less pickup, and do not affect the hand and appearance of the fabric so much.

Perhaps the simplest solution to this problem is the use of flameproof fibers such as glass, asbestos, polyvinylchloride and polyvinylidine chloride. Another approach to the problem has been the modification of the cellulose to form a phosphate ester or an amido-phosphate complex *(11)*. At present, this process is not simple to apply and control, and considerable loss in tensile strength may result. It has the advantage of not affecting the hand or appearance of the fabric very much.

VIII. Mildewproofing

The demand for durable mildewproofing has been greatest in connection with military fabrics. The phenyl-mercuric compounds and dichlor-dihydroxy-diphenyl-methane types were used to a considerable extent, and some degree of resistance to leaching-out was obtained. Where color was of less importance, copper naphthenate was used.

Mildewproofing agents were frequently combined with water-repellents or with flameproofing agents.

This problem can be approached in some applications by simply using mildew-resistant fibers, such as glass, polyvinyl fibers and cellulose acetate. Surface acetylation of cotton has been employed for this purpose *(12)*.

Summary

There is little doubt that the trend toward durable effects on rayon will continue to gather momentum in the future. The demand for *multiple* effects is already evident and fabrics frequently have to meet two or more durable finish specifications. Thus, some rayons must be shrinkage-controlled *and* crease-resistant, or flameproof *and* mildewproof.

Some of the above effects will be produced by the finisher and the complexity of modern finishing operations will in-

(Concluded on Page P29)

Fundamental Research Group Meeting—

The Effect of Fiber Physical Differences Upon the Dyeing of Nylon Staple*

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Introduction

SINCE nylon was first produced commercially in 1938, a very high proportion of its production has been supplied to the hosiery trade. However, because of its unique physical and chemical properties, the application of the continuous filament yarns in knitted and in woven fabrics has been and is being investigated extensively. The value of the results of this research is widely recognized.

It can be anticipated that nylon staple fiber will likewise exert a fundamental influence on the textile industry because it is so outstandingly different in its properties from other staples. Furthermore, its particular properties which are so outstanding are ones which contribute to fabrics properties of economic value. As more knowledge is gathered regarding the use of nylon staple in fabrics, the evidence points more and more to the ability of this fiber to contribute to selected types of fabrics qualities which will have real consumer appeal.

Uses of Staple

The common staples are, of course, cotton and wool. In addition, there are on the market today viscose process and acetate rayon staples. In comparison with continuous filament fabrics, fabrics manufactured from spun yarns are characterized by greater warmth, greater thickness, softer touch to the hand, and better draping properties. Among the fabric qualities which are likely to be improved greatly by the use of nylon staple are: durability, washability, dimensional stability, abrasion resistance and moth, fungi, mildew and alkali resistance. Also, lighter weight fabrics of equal or better wearing qualities and strength are obtainable by the use of nylon staple.

It is possible to "tailor-make" nylon staple for many applications. Actually, staple is now being produced in limited commercial quantities in 1.5, 3.0, 6.0 and 10 denier per filament and in lengths from one to five inches. As the denier per filament is increased, the staples become stiffer, less soft, and more springy in character. The staple length is governed by the system on which the yarns are to be spun. For example, 1-1/16 to 2.0-inch staple of all deniers per filament can be spun on the cotton system, and 2.5 to 7.0-inch staple of all deniers per filament can be spun on the woolen and worsted systems.

The coarser deniers, like 6 and 10, are used in the same manner as coarse wool —in blankets, rugs, upholstery and some heavy clothing. The finer deniers are used for finer grades of clothing. For example, the 3 denier is very suitable for such items as outerwear, underwear and men's hosiery. The 1.5-denier is used for light-weight clothing, light-weight hosiery, underwear and fine fabrics. Because of its very soft and cashmere-like hand, this denier is also used for fine sweaters. Thus, it is evident that dyers in many branches of the textile industry will be faced with the dyeing of nylon staple. Because of the imminence of this wide-spread introduction of nylon staple throughout the industry, it is considered appropriate to report at this time certain significant observations made on the dyeing of nylon staple even though there are still several questions left to be answered. These, we hope, will be satisfactorily explained by the investigations which are being continued.

The Manufacture of Staple

Because the physical alteration of the nylon during the staple manufacture has important implications with respect to the dyeing characteristics of the fiber, a brief description of the staple-manufacturing process should be considered at this point. Whereas nylon continuous filament yarns are drawn so as to have a residual elongation of 20 to 25 per cent, the undrawn nylon yarns to be converted to staple are drawn so that approximately 30 to 35 per cent residual elongation remains in the yarn. The material so drawn but not processed further is referred to herein as uncrimped rope.

The degree of crimp that is nearly optimum has been established and is of fundamental importance to the production of spun yarns that will produce acceptable end products. The crimped rope and cut staple used in this investigation contained the following numbers of crimps per inch:

1.5 denier per filament	= 19.8
3.0 denier per filament	= 13.4
6.0 denier per filament	= 13.1
10.0 denier per filament	= 8.6

These crimps were introduced mechanically.

After the rope has been crimped, it is cut to a predetermined length. It is this material which is sold to the processor as cut staple.

It is important to remember that nylon staple is engineered for the job and that nylon waste is not capable of producing end products of the same high quality.

Nylon Dyeing Practice

Due to irregularities in the affinity of nylon for acid and direct dyestuffs, the dyeing of hosiery and continuous filament nylon fabrics has been limited largely to the use of dispersed acetate colors since dyestuffs of this class are unequalled in covering nylon yarn of variable affinity. Although the dispersed acetate colors effectively mask fiber-to-fiber differences and thereby produce uniform shades on nylon, they unfortunately exhibit fastness to washing and in many cases to light which is not commensurate with the life of the nylon fiber.

* Presented at Fundamental Research Group Meeting, Dr. Leonard Armstrong, Presiding, National Convention, Chicago, October 24, 1947.

Acid and direct dyestuffs, on the other hand, may be applied to nylon from baths acidified with organic acids, e.g., acetic or formic acid, to yield colorations which withstand much more vigorous washing than the acetate dyeings. In many instances, these colors also show improved light fastness. However, under normal conditions of application to fabrics composed of continuous filament yarns, the use of acid and direct colors is attended with the hazard that variations in affinity may result in the formation of warp barré effects and filling bars Also, as Stott observed *(1)*, the acid colors are absorbed by nylon only in limited amounts. As the color concentration is increased, a saturation point is reached where the dyestuff ceases to be absorbed in the same relation as the quantity present in the dye bath.

In contradistinction to the dyeing of hosiery and fabrics composed of continuous filament yarn, goods composed of nylon staple yarns may be dyed with acid and direct colors without the danger of producing warp barré effects and filling bars. The staple is well blended and thereby there is produced a statistical distribution of yarn segments wherein the presence of individual fibers of irregular affinity is not accentuated. In fact, complete masking of minor differences in dye absorption is obtained and the over-all pattern is one of uniformly dyed yarn.

Experimental Data

In several mill trials involving the dyeing of materials containing nylon staple, it appeared that the nylon could be dyed in heavier strengths than had been indicated to be possible by the early dyeing studies of Stott *(1)* on continuous filament yarn. Preliminary laboratory tests confirmed that many acid dyestuffs were absorbed to a greater degree by nylon staple fiber than by continuous filament yarn of the same denier per filament. Therefore, the comparative affinity of textile-draw continuous filament, uncrimped and crimped staple-draw rope, and staple cut in various lengths, all prepared from delustered nylon filaments of four different deniers, was studied.

Preparation of Materials for Dyeing

Before dyeing, each nylon material was scoured for 15 minutes at 180° F. in a liquor containing:

2.0 g./l. soap,
1.0 g./l. "Duponol" D Paste and
1.0 g./l. trisodium phosphate.

The materials were rinsed thoroughly in running water and finally in distilled water. They were then dried and allowed to condition.

In any group of comparative dyeings, all of the materials involved were weighed before dyeing under the same conditions of temperature and relative humidity.

I—Relative Receptivities of Acid and Direct Dyestuffs

In his early studies of the dyeing of nylon continuous filament, Stott *(1)* directed attention to the fact that each acid dyestuff exhibited a definite percentage above which it ceased to be absorbed in the same relation as the quantity present in the dye bath which contained five per cent acetic acid and 40 per cent Glaubers salt. In the present investigation a similar value which is arbitrarily termed "receptivity" has been determined. Receptivity denotes that percentage of dyestuff absorbed in one hour at 200° F. from a bath containing 5.0 per cent acetic acid (28%) and an excess of the particular dyestuff.

1. *Method of Determination.* While excellent methods for the determination of dye absorption under carefully controlled temperature and volume conditions exist, they involve the use of more or less elaborate apparatus and are limited to the examination of a single dyeing at one time. Since the present study was regarded as somewhat embryonic, a less refined method in which several dyeings could be carried out simultaneously was selected. Samples of all of the different nylon materials, each weighing approximately 2.5 grams but carefully weighed to 0.001 gram, were wet out and then immersed in dye baths which contained 5.0 per cent acetic acid (28%) and a quantity of dyestuff carefully measured from a standard solution and which had been preheated by a water bath to 200° F. Dyeing was continued at 200° F. ± 2.0° F. for 60 minutes. A liquor: fiber ratio of 50:1 was maintained during this period by the addition of water at 200° F. to the dye bath as needed. All comparative dyeings proceeded simultaneously. At the conclusion of the dyeing period, the material was quickly removed from the bath and rinsed thoroughly in several volumes of cold water. The rinsings were combined with the residual dye liquor and, upon suitable dilution, the resulting solution was measured spectrally in the General Electric Recording Spectro-photometer. The unabsorbed dyestuff was determined by comparison with the spectral values of a blank dye bath, that is, a bath which had been prepared and heated as the others but in which no material had been immersed to absorb dyestuff. The amount of dyestuff absorbed was calculated by difference and in the following tables is expressed as a percentage based on the weight of the material. This technique had the advantage of permitting several materials to be dyed at one time and the results are considered comparative.

2. *Behavior of Different Dyestuffs.* The relative receptivity values of four dyestuffs* examined quantitatively by the above procedure appear in Table I. Inspection of the data for Du Pont Milling Red SWB Conc. 125% (C.I. 430), an acid color, and for Pontamine Green S Extra Conc. 125% (C.I. 583), a direct dyestuff, discloses that the receptivity of each crimped rope exceeds that of the corresponding uncrimped rope which in turn exceeds that of the corresponding filament yarn. The staple length does not appear to affect significantly the receptivities of the cut staple which are approximately the same as that of the crimped rope. Further examination of these data reveals that for Du Pont Milling Red SWB Conc. 125% and Pontamine Green S Extra Conc.

* The dye names used in the subsequent texts, tables and figures refer to the actual products employed in the investigation. Since other products (exclusive of mixtures) containing the same dye would behave similarly, although not necessarily yielding the same values, the Colour Index or Foreign Prototype Number, as listed in the AATCC 1946 Year Book, pages 316 to 511, is given in parenthesis immediately following the initial appearance of the product name.

TABLE I

Relative Receptivities of Filaments, Ropes and Staple of Different Denier

Dyestuff	% dye initially in bath	Denier per Filament	Filament Yarn	Grams dye absorbed per 100 grams fiber in 60 minutes at 200°F. Rope Uncrimped	Rope Crimped	Cut Staple 5-inch	Cut Staple 2.5-inch	Cut Staple 1.5-inch
Du Pont Milling Red SWB Conc. 125% (C.I.430)	5.0	1.5	2.47	2.48	3.27	3.24	3.25	3.22
		3.0	1.72	2.34	2.98	2.99	2.73	2.91
		6.0	1.50	1.98	2.44	2.34	2.44	2.42
		10.0	1.22	1.66	1.78	1.76	1.78	1.77
Pontamine Green S Extra Conc. 125% (C.I.583)	10.0	1.5	2.70	3.01	4.15	4.54	4.52	4.88
		3.0	1.74	2.20	3.32	3.52	3.32	3.20
		6.0	1.09	1.68	2.42	2.50	2.24	2.24
		10.0	0.59	0.66	1.04	0.92	0.99	1.09
Pontacyl Light Yellow GX (C.I. 639)	5.0	1.5	0.89	0.90	0.83	0.87	0.87	0.84
		3.0	1.13	0.96	1.02	0.98	1.00	1.02
		6.0	1.33	1.15	1.17	1.14	1.10	1.17
		10.0	1.07	1.17	1.02	1.02		1.10
Du Pont Milling Yellow 5G Conc. (C.I. 642)	10.0	1.5	4.08	4.38	4.91	4.97	4.82	5.00
		3.0	4.66	4.53	4.81	4.64	4.64	4.70
		6.0	4.72	4.29	4.66	4.68	4.61	4.76
		10.0	3.94	3.92	3.94	3.89	3.89	3.86

NOTE: 5.0% acetic acid (28%) on the weight of the fiber used in each of the above dye baths.

125% the receptivities decrease as the denier per filament is increased.

Observation of the data in Table I for Pontacyl Light Yellow GX (C.I. 639) reveals that there is no significant increase in the receptivity of the crimped rope or cut staple over that of the uncrimped rope or over that of the filament yarn for any of the four different denier per filaments examined. As a matter of fact, the receptivity of the uncrimped rope is noticeably less than that of the filament yarn in the case of the 3.0 and 6.0 denier per filament materials. This difference has also been observed when residual dye is exhausted on wool. Peculiarly, the receptivity of the filament yarn increases as the denier per filament is increased from 1.5 to 6.0 but that of the 10.0 denier per filament yarn is considerably less than that of the 6.0 denier per filament yarn.

The data in Table I for Du Pont Milling Yellow 5G Conc. (C.I. 642) disclose that the receptivity of the crimped rope and cut staple appreciably exceeds that of the filament yarn only in the case of the 1.5 denier per filament materials. Also, there is no progressive decrease in the receptivity of the filament yarn as the denier per filament is increased. As a matter of fact, the receptivity increases up to 6 denier per filament and then decreases sharply for the 10 denier per filament continuous filament yarn. It is true that the cut staple exhibits a moderately progressive decrease in receptivity as the denier per filament is increased but closer examination indicates that the greatest decrease occurs between the 6.0 and the 10.0 denier per filament staple and that the other decreases are comparatively minor.

Because the receptivities of Du Pont Milling Red SWB Conc. 125% and of Pontamine Green S Extra Conc. 125% were so markedly affected by the physical variations in the nylon whereas those of Pontacyl Light Yellow GX and of Du Pont Milling Yellow 5G Conc. were relatively slightly affected, cross-sections were prepared. In Figures 1 and 2 photomicrographs of 3.0 denier per filament continuous filament yarn, uncrimped rope and cut staple dyed with Du Pont Milling Red SWB Conc. 125% and with Pontamine Green S Extra Conc. 125% respectively are exhibited. With both of these dyes the increased receptivity of the uncrimped rope over that of the continuous filament yarn and that of the cut staple over the uncrimped rope are reflected by increased penetration of the fiber. In view of the lower draw ratio of the uncrimped rope, 3.66 as compared to 3.88 for the continuous filament yarn, which was employed to produce the required residual elongation, the improvement in the receptivity and penetration of these dyes on this material is attributed to its lower degree of molecular orientation. The further increase in receptivity and penetration exhibited by the crimped rope and the staple indicate that the crimping proc-

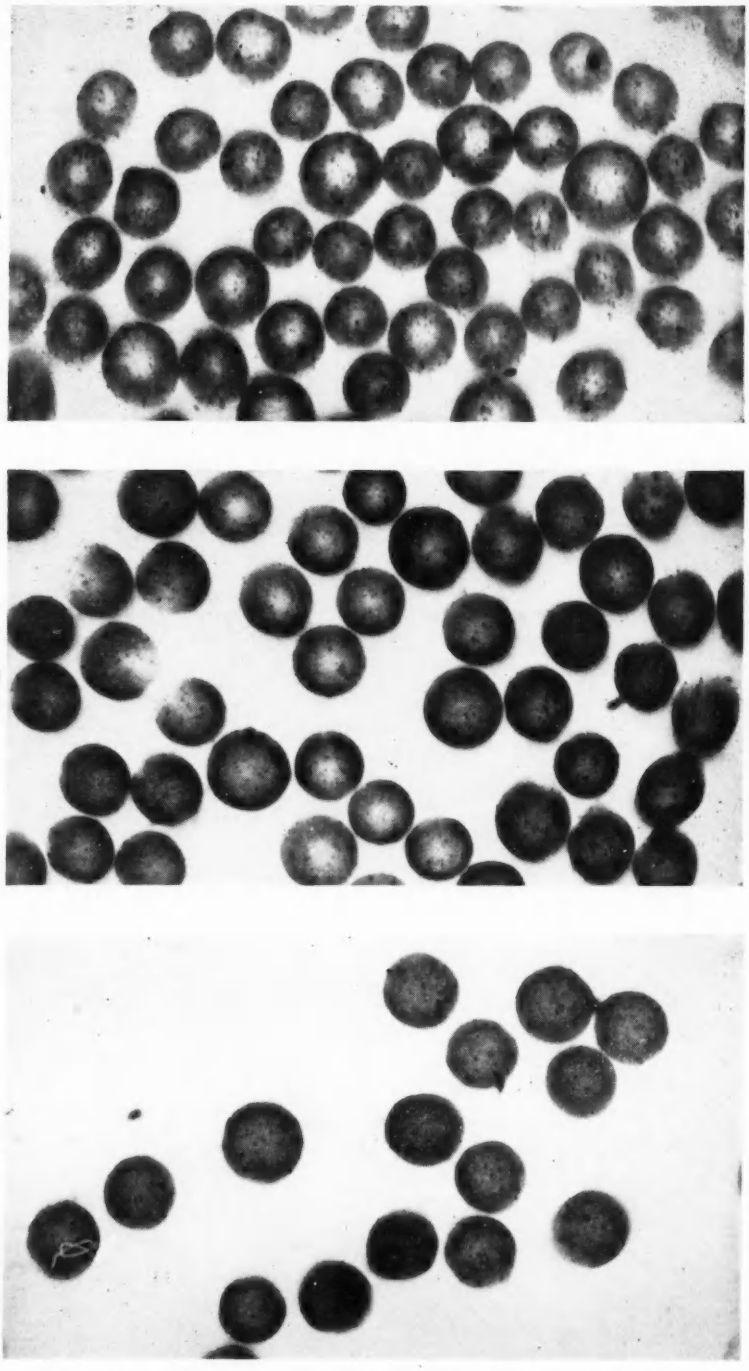

Figure 1. Du Pont Milling Red SWB Conc. 125% (C.I. 430) on 3.0 denier per filament nylon:
A. Continuous filament yarn
B. Uncrimped rope
C. Cut staple
Magnification = 552X. Section thickness = 20 microns. Filter = C-5 Wratten Blue.

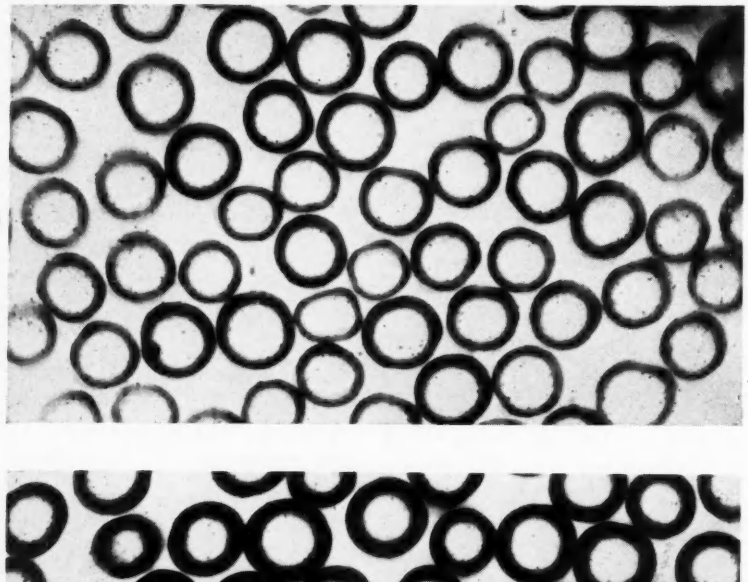

Figure 2. Pontamine Green S Extra Conc. 125% (C.I. 583) on 3.0 denier per filament nylon:
A. Continuous filament yarn
B. Uncrimped rope
C. Cut staple
Magnification = 552X. Section thickness = 20 microns. Filter = A Wratten Red.

ess itself has "opened up" the fiber still more.

The decrease in receptivity with increasing denier per filament which occurred in the Du Pont Milling Red SWB Conc. 125% and the Pontamine Green S Extra Conc. 125% series of dyeings may be explained by geometrical analysis. If a dye can migrate into the fiber only a given distance in the period of dyeing, the cross-sectional area remaining undyed will be greater in the coarser filaments than in the finer filaments. Hence, assuming saturation in the dyed areas, the percentage of dye absorbed will be less as the denier per filament is increased.

In contradistinction to the incomplete penetration of the continuous filament yarns by Du Pont Milling Red SWB Conc. 125% and by Pontamine Green S Extra Conc., both Pontacyl Light Yellow GX and Du Pont Milling Yellow 5G Conc. completely penetrate even the 10.0 denier per filament continuous filament yarn. Figures 3 and 4 are photomicrographs of cross-sections of 10.0 denier per filament continuous filament yarn and cut staple, both dyed with Pontacyl Light Yellow GX and Du Pont Milling Yellow 5G Conc.

In view of the decrease which occurred between the 6.0 and the 10.0 denier per filament continuous filament yarn with both the Pontacyl Light Yellow GX and the Du Pont Milling Yellow 5G Conc. it was thought that this might conceivably be due to a rate of penetration factor. Therefore, dyeings were made on continuous filament yarn and on 2.5-inch cut staple of the four different denier per filament materials with 10.0 per cent Du Pont Milling Yellow 5G Conc. at 200° F. for one and three hours. The dye receptivities were then determined spectrally as above and are listed in Table II. The values for the 10.0 denier per filament materials do approach equality as the time of dyeing is extended. In this group of comparative dyeings the progressive increase in receptivity as the denier per filament increased from 1.5 to 6.0 and the decrease of the 10.0 denier per filament over that of the 6.0 denier per filament was again apparent. The latter drop however was less pronounced as the time of dyeing was extended to three hours. As for the cut staple, there was a progressive decrease in receptivity as the denier per filament was increased from 1.5 to 10.0 in both these dyeings which were carried out for one hour and those which were carried out for three hours. However, the magni-

TABLE II

Effect of Dyeing Time on the Absorption of Du Pont Milling Yellow 5G Conc. (C.I. 642)

Denier per Filament	Grams dye absorbed by 100 grams fiber at 200°F. Filament Yarn 1 hour	Filament Yarn 3 hours	2.5-inch Cut Staple 1 hour	2.5-inch Cut Staple 3 hours
1.5	4.23	4.59	5.19	5.22
3.0	4.50	4.65	4.86	4.96
6.0	4.69	4.99	4.77	4.78
10.0	4.28	4.85	4.11	4.56

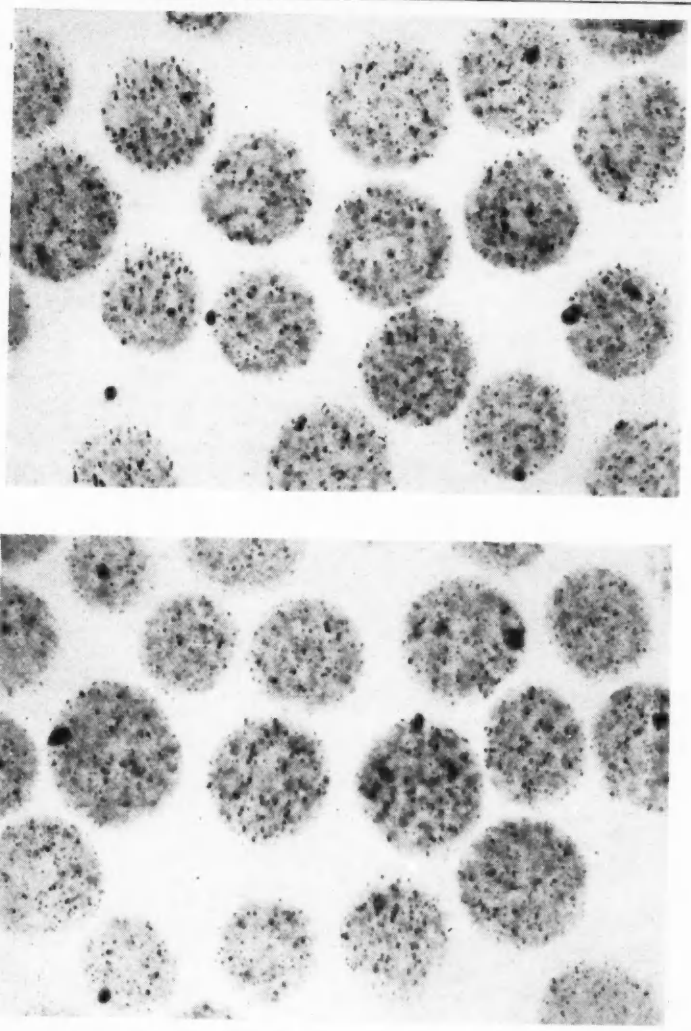

Figure 3. Pontacyl Light Yellow GX (C.I. 639) on 10 denier per filament nylon:
A. Continuous filament yarn
B. Cut staple
Magnification = 552X. Section thickness = 20 microns. Filter = C-5 Wratten Blue.

tude of this decrease was much less than that observed for the non-penetrating or "ringer"-type dyes.

II—Relative Degree of Exhaust of Penetrating and Non-Penetrating Acid and Direct Dyestuffs

Since the cut staple dyed heavier than the uncrimped rope and that in turn heavier than the continuous filament yarn with Du Pont Milling Red SWB Conc. 125% and with Pontacyl Green S Extra Conc. 125%, confirmation of this trend with other "ringer"-type dyes was obtained. Dyeings were made for one hour at 200° F. with several "ringer"-type dyes on continuous filament yarn, uncrimped rope and cut staple in both 3.0 and 10.0 denier per filament materials from baths containing 5.0 per cent acetic acid (28%) and a slight excess of dye over that required to saturate the 3.0 denier per filament cut staple. In all cases, 2.50 grams of nylon was dyed. At the end of the dyeing period the nylon was removed from the dye bath, and the excess dye liquor was expressed therefrom and returned to the residual dye bath. The nylon was also rinsed in water and the rinsings combined with the residual dye bath. Pieces of woolen crepe fabric, weighing 2.50 grams each, were wet out and introduced into each dye bath respectively. The residual dye in each bath was then exhausted completely on the woolen crepe by the judicious addition of acid. In all cases the woolen crepe pieces dyed in the residual baths from the 10.0 denier per filament nylon materials were dyed heavier than those which were dyed in the residual baths of the 3.0 denier per filament nylon materials. This indicates that with all of these dyes, the 3.0 denier per filament nylon absorbs more dyestuff than the 10.0 denier per filament nylon. Furthermore, the woolen pieces dyed in the residual baths from the continuous filament yarns were dyed heavier than those which were dyed in the residual baths from the uncrimped rope which in turn were dyed heavier than those dyed in the residual baths from the cut staple.

The following non-penetrating dyes were applied according to the above procedure:

3.0% Pontamine Fast Orange 2GL
2.5% Pontamine Fast Red FCB Conc. 150% (C.I. 419)
4.0% Pontacyl Fast Blue GB Extra Conc. 125% (C.I. 289)
1.0% Pontacyl Carmine 6B Extra Conc. 125% (C.I. 57)
1.0% Pontacyl Fast Violet 10B Conc. 175% (C.I. 696), as well as with
2.5% Du Pont Milling Red SWB Conc. 125%.

In general, for each dyestuff the woolen pieces on which the residual dye from the 10.0 denier per filament nylon materials was exhausted were considerably heavier than the woolen pieces dyed in the residual dye liquors from the 3.0 denier per filament nylon materials. In the case of the 3.0 denier per filament materials, the wool dyed in the residual liquor from the continuous fiament yarn was considerably heavier than that dyed in the residual liquor from the uncrimped rope, and this in turn was dyed much heavier than that dyed in the residual dye liquor from the cut staple. The analogous dyeings on wool from the residual liquor of the 10.0 denier per filament nylon materials exhibited differences which were much less pronounced and with some colors indistinct. This is not particularly surprising, however, if the increased receptivity of the cut staple is due to the crimping "opening up" the fiber, for as was stated previously the 10.0 denier per filament staple contained fewer crimps per inch than the 3.0 denier per filament staple. Even if the 10.0 denier per filament fiber were opened to the same degree as the 3.0 denier per filament fiber, there still might be a very large proportion of the coarser fiber inaccessible to the dyestuff. A photograph of the exhaust dyeings on wool of four of the above dyestuffs appears as Figure 5.

When similar experiments were carried out with penetrating dyestuffs, the wool dyed in the residual dye bath was approximately the same strength regardless

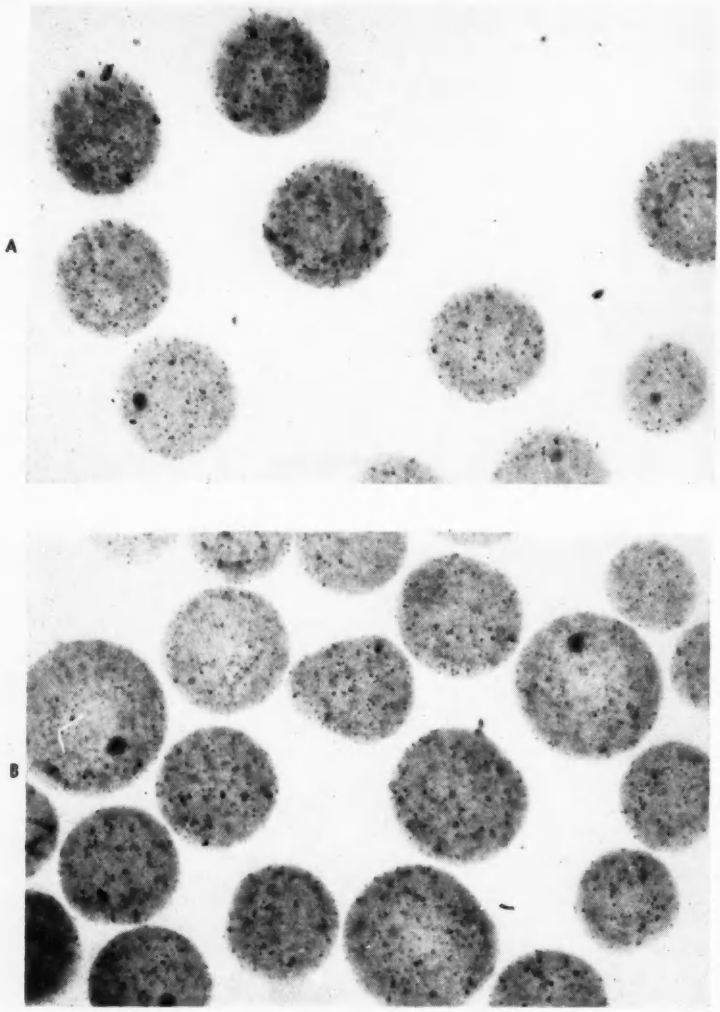

Figure 4. Du Pont Milling Yellow 5G Conc. (C.I. 642) on 10 denier per filament nylon:
A. Continuous filament yarn
B. Cut staple
Magnification = 552X. Section thickness = 20 microns. Filter = C-5 Wratten Blue.

of the nylon materials which had been originally dyed in the bath. In some cases, slight differences indicated greater absorption by the filament yarn over the staple but absorption was practically the same throughout by each of the six nylon materials dyed with each of the penetrating dyestuffs. Penetrating dyes applied in this experiment included:

1.5% Du Pont Crocein Scarlet N Extra (C.I. 252)
1.5% Pontacyl Carmine 2G Conc. 150% (C.I. 31)
3.0% Du Pont Anthraquinone Violet 3R (C.I. 1080)
2.0% Du Pont Anthraquinone Blue BN (C.I. 1054)

and the essential equality in the strength of the exhaust dyeings is indicated by the photograph in Figure 6. Dyeings were also made with

1.5% Pontacyl Light Yellow GX and
4.0% Du Pont Milling Yellow 5G Conc. in which

0.2% Du Pont Anthraquinone Blue BN was added to the residual dye liquors in order to ascertain the differences in the amount of yellow exhausted on the wool.

In order to show the similarity between the behavior of the penetrating acid dyestuffs and dispersed acetate colors a set of dyeings similar to the above was made with 3.0 per cent Celanthrene Pure Blue BRS 400% dispersed with soap and "Duponol" D Paste and the non-absorbed dyestuff was exhausted on cellulose acetate satin fabric. The resulting dyeings on acetate were essentially equal.

III—Rate of Dye Absorption

Stott *(1)* also classified acid dyestuffs according to the rate at which they were exhausted from an acetic acid-containing dye bath. He placed the dyes according to the amount of dyestuff absorbed by the fiber in the first five minutes (from a bath containing one-half the amount of dye equivalent to the saturation point) in the following categories:

Very rapid — 90 to 100%
Rapid — 80 to 89%
Medium — 70 to 79%
Slow — 55 to 69%

It has now been observed that dyes are absorbed more rapidly as well as in greater quantity by cut staple than by the corresponding continuous filament yarn. The same technique involving spectral measurement of the unabsorbed dyestuff as was used in determining the receptivity was employed except that dyeing times of 2, 5, 10, 20, 40 and 60 minutes were used. The absorption rate curves for Du Pont Milling Yellow 5G Conc., a very rapid dyeing color, is illustrated in Figure 7, for Du Pont Milling Red SWB Conc. 125%, a rapid dyeing color, in Figure 8 and for Du Pont Anthraquinone Violet 3R (C.I. 1080), a slow dyeing color, in Figure 9. The latter graph also shows that absorption proceeds more slowly in the materials of 10 denier per filament than in those of 3.0 denier per filament.

IV—Comparative Fastness Properties of Dyes on Continuous Filament and on Staple Yarns

Several acid and direct colors were dyed in 1.0 per cent strength on continuous filament yarn and on yarns of 5.0-inch and 1.5-inch staple respectively from baths containing 5.0 per cent acetic acid (28%) for one hour at 200° F. Two acetate colors, Acetamine Scarlet B (Pr. 244) and Celanthrene Brilliant Blue FFS Conc. 200% (Pr. 288), dispersed with soap and "Duponol" D Paste were also applied to these yarns in 1.0 per cent strength. The nylon used in the manufacture of these three yarns was 3.0 denier per filament. All of the baths completely exhausted on the nylon.

1. *Light Fastness.* Specimens of the three dyeings of each of several of these colors were mounted side by side on a panel and exposed in the Fade-Ometer. The comparative ratings given in Table III indicate that there is no significant dif-

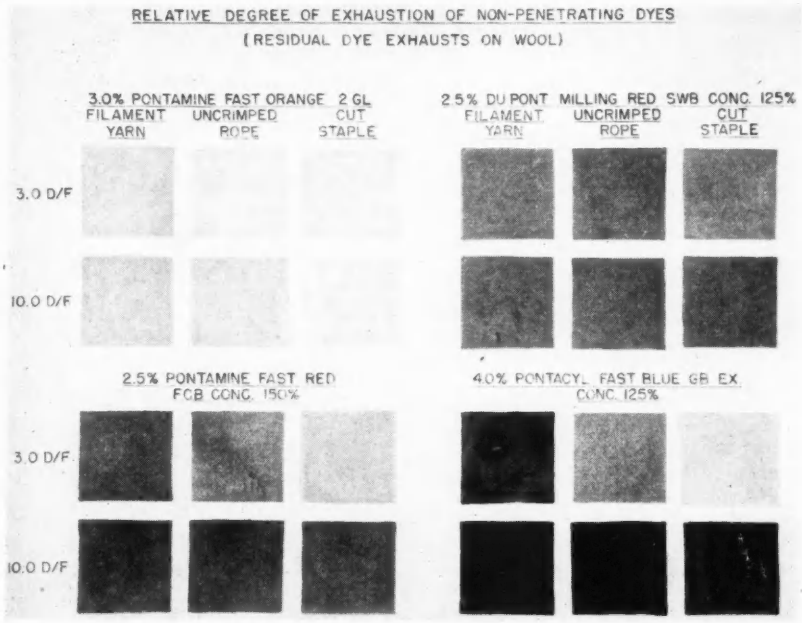

Figure 5

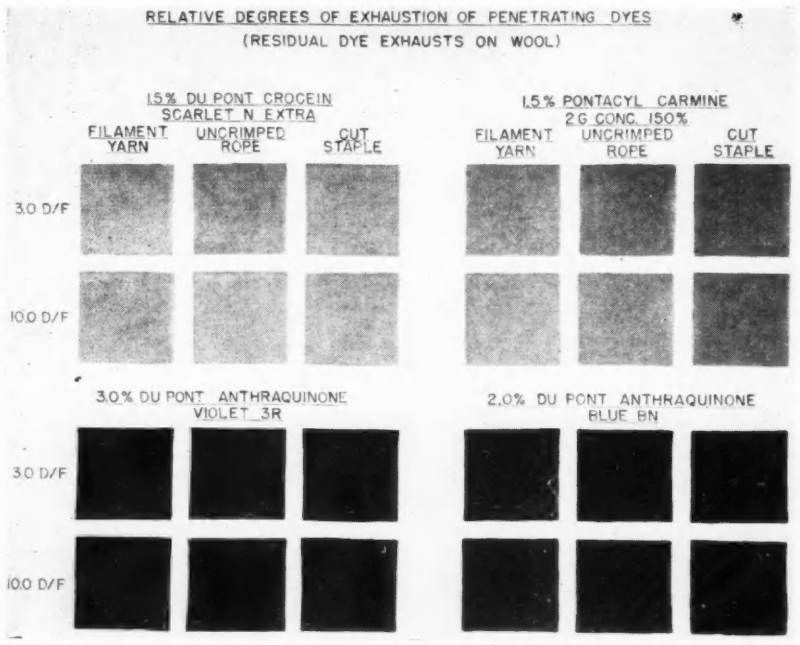

Figure 6

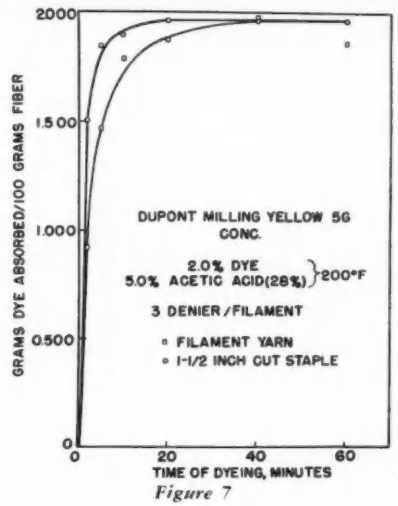

Figure 7

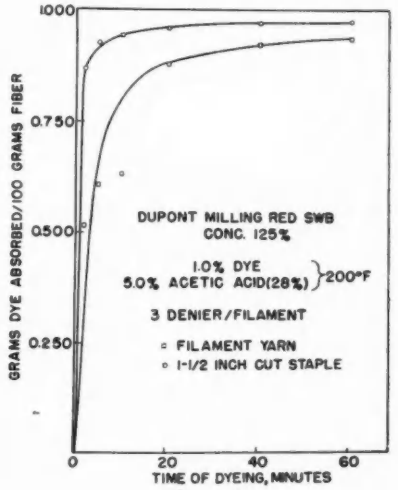

Figure 8

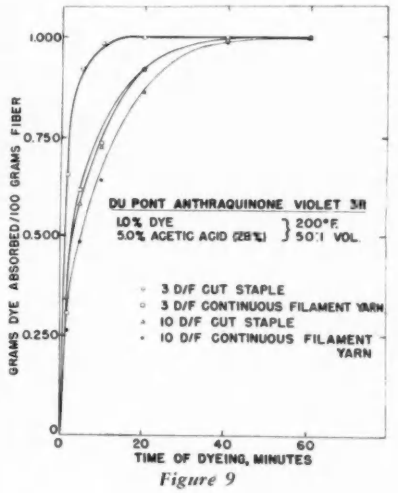

Figure 9

ference between the light fastness of equal strength dyeings on filament and on staple.

2. *Wash Fastness.* Specimens of each of the acid and direct color dyeings on the three yarns were braided with cotton, wool, bright cellulose acetate and nylon yarns. The braids were then subjected to three AATCC No. 3 Wash Tests (5.0 grams soap per liter for 30 minutes at 160° F.) which is a severe test for synthetic fibers. After each washing they were thoroughly rinsed and dried. Visual examination disclosed that in all cases, except in that of Pontamine Fast Red FCB Conc. 150% (C.I. 419), the wash fastness of the dyeings on the staple yarns was in-

TABLE III

Comparative Light Fastness of 1.0% Dyeings on 3.0 Denier per Filament Continuous Filament and Cut Staple Yarns

Dyestuff	Fade-Ometer Exposure Hours	Fastness Ratings Filament Yarn	Staple Yarns 5-inch	Staple Yarns 1.5-inch
Du Pont Milling Yellow 5G Conc. (C. I. 642)	40	4W	4W	4W
Pontamine Fast Orange 2GL	40	5–4W	5–4W	5–4W
Chromacyl Orange R (Pr. 146)	40	5–4W	5–4W	5–4W
Du Pont Milling Red SWB Conc. 125% (C. I. 430)	20	5–4W	5–4W	5–4W
Acetamine Scarlet B (Pr. 244)	10	2Y	2Y	3Y
Pontamine Fast Red FCB Conc. 150% (C. I. 419)	40	4–3DW	4DW	4DW
Chromacyl Bordeaux R (Pr. 145)	40	3W	3W	3W
Celanthrene Brilliant Blue FFS Conc. 200% (Pr. 228)	20	4RD	3RD	3RD
Chromacyl Blue GG Conc. 200% (Pr. 144)	20	4W	4W	4W
Du Pont Anthraquinone Green GN (C. I. 1078)	40	4W	4W	3W

NOTE: The letters and numerals used in the above ratings of shade change denote:

5–4 = trace
4 = noticeably
3 = appreciably
2 = considerably
D = duller
R = redder
W = weaker
Y = yellower

TABLE IV

Relative Wash Fastness of Acid and Direct Color Dyeings on 3.0 Denier per Filament Continuous Filament and Staple Yarns

1.0% Dyeing of:	% Dye Removed by Three AATCC No. 3 Wash Tests Filament Yarn	Staple Yarns 5-inch	Staple Yarns 1.5-inch
Pontacyl Light Yellow GX (C. I. 639)	50	63	69
Du Pont Milling Yellow 5G Conc. (C. I. 642)	24	41	44
Chromacyl Orange R (Pr. 146)	2	29	27
Pontamine Fast Orange 2GL	6	15	9
Du Pont Milling Red SWB Conc. 125% (C. I. 430)	7	10	19
Pontamine Fast Red FCB Conc. 150% (C. I. 419)	25	17	12
Chromacyl Bordeaux R (Pr. 145)	3	11	16
Chromacyl Blue GG Conc. 200% (Pr. 144)	15	17	19
Du Pont Anthraquinone Green GN (C. I. 1078)	21	28	33

TABLE V

Relative Wash Fastness of Dispersed Acetate Color Dyeings on 3.0 Denier per Filament Continuous Filament and Staple Yarns

1.0% Dyeing of:	Number of Times Washed	% Dye Removed on Washing by AATCC No. 1 Wash Tests Filament Yarn	Staple Yarns 5-inch	Staple Yarns 1.5-inch
Acetamine Scarlet B (Pr. 244)	2	16	24	31
	5	22	33	41
Celanthrene Brilliant Blue FFS Conc. 200% (Pr. 228)	2	25	26	39
	5	40	43	54

ferior to that of the corresponding dyeing on the continuous filament yarn.

In order to determine more or less quantitatively the relative amount of dye removed in washing, random samples weighing 100 milligrams each of the washed specimens and of the corresponding unwashed dyeings were dissolved in ortho-chlorphenol at a temperature less than 100° C. and the relative amount of dye on the washed yarn with respect to the unwashed yarn was determined by spectral measurement in the General Electric Recording Spectrophotometer. The percentages of the dyes removed on washing which are presented in Table IV substantiate the visual evaluations.

The two acetate color dyeings were subjected to two and to five AATCC No. 1 Wash Tests (5.0 grams soap per liter for 30 minutes at 105° F.). The amount of dye removed by washing was determined by the ortho-chlorphenol technique. These values exhibit a similar trend to those for the acid color dyeings and are listed in Table V.

Included in the group of acid colors were two penetrating dyes, Pontacyl Light Yellow GX and Du Pont Milling Yellow 5G Conc. These, like the acetate dyes, followed the same trend exhibited by the "ringer"-type acid dyes. It is very apparent that, with the exception of Pontamine Fast Red FCB 150%, the wash fastness of each of these dyes on the staple yarns is inferior to that of the corresponding dyeing on continuous filament yarn. Nevertheless, the wash fastness of the acid colors on either continuous filament or cut staple yarn is, in general, much superior to that of acetate colors which exhibit appreciable losses in strength even when washed at 105° F.

The fact that dyestuffs are removed by washing to a greater degree from staple yarn than from filament yarn also supports the theory that the pores of the staple are larger than those of the filament yarn. To put it another way, the crimping process has "opened up" the fiber. As the dye penetrates into the staple fiber more easily than into the continuout filament fiber, one would expect it to be removed more easily. However, since Pontamine Fast Red FCB Conc. 150% exhibits the opposite effect, the need for further studies of this and other direct dyestuffs is indicated. It could be that this dyestuff aggregates to a greater degree in the staple fiber than in the continuous filament fiber and, hence, removal from the former is inhibited.

V—Comparative Fastness Properties on Yarns of Different Denier per Filament

Initially, the continuous filament yarns in the four different denier per filaments were dyed with 1.0 per cent of each of four selected acid and direct dyestuffs. In all cases the dye was completely absorbed by the fiber. It was evident from these dyeings that as the denier per filament increased, the visual strength of the dyeing also increased. A similar observation was made on staple yarns prepared from nylon of 3.0, 6.0 and 10.0 denier per filament. This is analogous to the observation which was made by Boulton et al. with respect to viscose process rayon *(2)* and which has recently been discussed in some detail as to its practical significance by Boulton and Wardle *(3)*.

1. *Light Fastness.* Dyeings were made with increased concentrations of dyestuffs on the finer denier per filament continuous filament yarn in order to approximate the visual strengths of the 10.0 denier per filament yarn. Specimens of the visually similar dyeings were mounted on panels and exposed for 40 hours in the Fade-Ometer. The light fastness ratings given in Table VI indicate that the visually equal dyeings on the continuous filament yarns are not significantly affected by the difference in denier.

2. *Wash Fastness.* It was considered theoretically of interest to measure the relative amount of dye removed by washing from continuous filament yarns of different denier per filament. Accordingly, the 1.0 per cent dyeings were subjected to three repeated AATCC No. 3 Wash Tests and the amount of dye removed thereby was determined by the ortho-chlorphenol technique described above. The data so obtained are presented in Table VII. These values indicate that the penetrating dyes, Du Pont Anthraquinone Violet 3R (C.I. 1080) and Du Pont Anthraquinone Green GN (C.I. 1078), exhibit definitely inferior wash fastness on continuous filament of 1.5 denier than on coarser deniers. No correlation between the denier per filament and the wash fastness was apparent with the "ringer" dyes, Du Pont Milling Red SWB Conc. 125% (C.I. 430) and Pontamine

TABLE VI

Comparative Light Fastness of Visually Similar Dyeings on Continuous Filament Yarns of Different Denier per Filament

(40-hours Fade-Ometer Exposure)

Denier per Filament	Du Pont Milling Red SWB Conc. 125% (C. I. 430)		Du Pont Anthraquinone Violet 3R (C. I. 1080)		Du Pont Anthraquinone Green GN (C. I. 1078)		Pontamine Green S Extra Conc. 125% (C. I. 583)	
	% dye	Rating	% dye	Rating	% dye	Rating	% dye	Rating
1.5	1.6	4W	2.0	5–4W	2.0	4W	1.6	3W
3.0	1.4	4W	1.5	5–4W	1.5	4W	1.4	3W
6.0	1.2	4W	1.1	5–4W	1.1	4W	1.1	3W
10.0	1.0	4W	1.0	5–4W	1.0	4W	1.0	3W

NOTE: The letters and numerals used in the above ratings of shade change denote:
5–4 = trace
4 = noticeably
3 = appreciably
W = weaker

TABLE VII

Comparative Wash Fastness of Dyeings on Continuous Filament and Staple Yarns of Different Denier per Filament

% dye removed from 1.0% dyeings by three AATCC No. 3 Wash Tests

Denier per Filament	Du Pont Milling Red SWB Conc. 125% (C. I. 430)	Du Pont Anthraquinone Violet 3R (C. I. 1080)		Du Pont Anthraquinone Green GN (C. I. 1078)		Pontamine Green S Extra Conc. 125% (C. I. 583)
	Continuous Filament	Continuous Filament	Staple Yarn	Continuous Filament	Staple Yarn	Continuous Filament
1.5	8	37		41		3
3.0	10	13	39	19	25	8
6.0	11	13*	27	14*	24	4
10.0	3	8	29	14	29	2

*1.1% dyeing.

Green S Extra Conc. 125% (C.I. 583). Other "ringer" and penetrating dyes will be examined to determine whether or not the results observed here are typical of each class. Insufficient samples of staple yarns have been examined to conclude that the same trend will hold for them. However, those which were included exhibited wash fastness inferior to that of the corresponding dyeings on continuous filament yarn.

Practical Considerations

Although this investigation has been directed primarily toward the establishment of fundamental facts, the results are nevertheless of practical significance. In the dyeing of heavy shades on coarse staple penetrating dyes will probably have to be selected in order to produce the required strength since non-penetrating dyes will not be absorbed in sufficient quantity by these fibers. It is improbable that the advantage in visual strength naturally inherent in fibers of high denier will compensate for the restricted dye receptivity. On the other hand, in the dyeing of heavy shades on fabrics composed of staple nylon of the finer deniers, the "ringer"-type dyes are capable of producing heavier dyeings than on filament nylon. This may be of advantage in dyeing nylon equal to wool in nylon-wool blends.

Experiments bearing directly on the practical aspects are being carried out in a continuation of this investigation. It is anticipated that greater difficulty might be experienced in matching compound shades with "ringer"-type dyes than with penetrating dyes because of the markedly greater variation in the affinity of the former toward nylons of different denier per filament. Also, attention will be directed to an evaluation of the wash fastness of a broad range of acid and direct colors on nylon of varying denier per filament.

Summary

Nylon staple has been found to exhibit greater receptivity for non-penetrating acid and direct dyestuffs than continuous filament yarn of the same denier per filament. The receptivity for non-penetrating dyes decreases as the denier per filament increases. On the other hand, penetrating dyestuffs exhibit relatively little variation in receptivity between staple and continuous filament nylon or among nylons of different denier per filament. In general, the receptivity of acid and direct dyes, both penetrating and non-penetrating, appears to be independent of the staple length. The wash fastness of all of the acetate, acid and direct dyestuffs examined, with one exception, is inferior on staple nylon yarns compared to continuous filament nylon yarns but the light fastness is unaffected by fiber physical variations. However, nylon staple dyed with acid and direct dyestuffs is faster to washing than continuous filament nylon dyed with acetate colors. Because of this superiority in wash fastness, and in some cases in light fastness, the acid colors will be used for the dyeing of nylon staple fabrics in which minor variations in the affinity of the fiber may be expected to be masked completely.

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Permanent Finishes—

(Concluded from Page P20)

creased. Other effects will be produced by the use of new synthetic fibers which possess the desired properties.

In any case, the consumer will benefit by the fact that rayon garments will not lose their desirable characteristics on laundering or dry-cleaning.

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CALENDAR

PHILADELPHIA SECTION

Meetings: February 27, April 9, May 14 (Kugler's, Philadelphia).

NEW YORK SECTION

Meeting: January 23, and March 12 (Hotel New Yorker, N. Y.); May 7 (Swiss Chalet, Rochelle Park, N. J.).

PIEDMONT SECTION

Meetings: February 7 (Poinsett Hotel, Greenville, S. C.); April 3 (Robt. E. Lee Hotel, Winston-Salem, N. C.); June 18 (Ocean Forest Hotel, Myrtle Beach, S. C.).

NORTHERN NEW ENGLAND SECTION

Meetings: January 23, March 19 (Boston); April 16 (Lowell Textile Institute); May 21, June 11 (Outing), September 24 (Andover Country Club); November 19.

Finishing and Auxiliaries Group Meeting—

Anionic Substantive Softeners*

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Research Director
Arnold, Hoffman & Co., Inc.

ALTHOUGH the expression "Anionic Substantive Softeners" is relatively new, anionic compounds, as such, are old. Soap is one of the oldest examples of an anionic compound, dating back as far as 2 or 1 B.C.[1] At that time, its use was confined chiefly to the washing of clothes or persons. Following 1 B.C., centuries passed before it came into use again, as a result of the olive trees in France. Olive oil soap was produced in France during the 13th century and some soap manufacturing sprung up in England during the 14th century. However, few industrial plants were operated before 1800.

In 1608, soap was first made in America, and in the year 1776, a British patent,[2] for cleaning woolen cloth was granted. Approximately one hundred years ago, soap was first used to impart waterproofing qualities to piece goods, the fabrics first being impregnated with a soap solution, dried and then passed through a bath containing aluminum acetate. The resulting metallic soap rendered the cloth water-repellent.

Other well-known anionic compounds are sulfated oils, stearic acid softeners and other fatty acid soaps. Many surface-active agents, such as Gardinols, Nekals or Deceresols are likewise anionic in nature, being sodium salts of sulfated alcohols, alkyl naphthalenes and esters of dibasic acids, respectively. Sulfated oils, sulfated alcohols and fatty acid softeners are used a great deal today, when permanent softness is not required. These products are not substantive, however, and are completely removed in the first washing, or even by a mild rinsing in warm water. Sulfated oils also give varied finishing effects, due to the source of raw oil used, the degree of sulfation and the type of wash to which the oil was subjected. Oils of iodine value over ninety tend to yellow the fabric and become rancid. Stearic acid softeners give a good finish, but are easily removed and tend to yellow under heat.

*Presented at Finishing and Auxiliaries Group Meeting, Clarence W. Wille, presiding, National Convention, Chicago, October 24, 1947.

The term "anionic" has always been associated with products as mentioned above. Heretofore, any product in which the softening portion of the radical was located in the negative ion or anion has been considered a regular softener, not substantive in nature. It has been found that it is possible to produce a class of compounds which are alkali metal salts of high molecular weight fatty amides[3] and fatty carbamides,[4] in which there is a large negative ion, substantive to rayon and cotton.

About 1936-1938, the use of substantive softeners became widespread, these compounds being acetate salts of alkylated products of fatty amides or fatty imidazoles. With a pH of 4-5, these softeners were compatible with a great many finishes, but they could not be used with sulfated oils and other anionic products. All of these products in water gave a large positive ion or cation and were called "Cationic Softeners." Very low concentrations were used to produce a soft fabric. Exhaustion on rayon and cotton was good, and it was common practice to apply the softener directly after dyeing, care being taken that the goods were thoroughly rinsed before the fatty amide was added to the dye-beck. In general, stearic acid constitutes the softening portion of the product, it being condensed with organic amines at elevated temperatures to form the amide, after which the amide base is solubilized with acetic acid or alkylated with the usual alkylating agents.

Shortly after the introduction of "cationic" finishes, serious trouble arose when it was found that certain classes of dyes were adversely affected by the fatty amide salts. A direct dyestuff that would normally stand forty hours' Fade-o-Meter exposure showed fading in five or ten hours, and in forty hours, was nearly destroyed. Depending on the structure of the amide, varying degrees of light fastness could be obtained with the same dyestuff, but all directs were affected and some Rapidogens, vats and Indigosols. All of the cationic softeners on the market showed this effect. By 1939, complaints showed that dress goods treated with cationic softeners faded after having been displayed in store windows for relatively short periods of exposure. In considering the problem presented by the use of quaternary compounds or cationic softeners, three or four factors could be considered responsible:

1. Oxidation
2. Reduction
3. Impurities present
4. Some specific group present

Various reducing and oxidizing agents were added to different fatty amides, both during condensation and in the final paste, but negative results were obtained. The presence of oxidizing agents in cationic compounds increased fading, and reducing compounds in general had no affect. Condensation of the fatty acid and organic amine in inert atmosphere had no affect on the final results, as condensations made under nitrogen still adversely affected light stability of direct dyestuffs. Substituting sulfur dioxide for nitrogen during condensation did not reduce fading tendencies.

A series of experiments using fatty acids with varying degrees of unsaturation were carried out, their iodine values running from 1.61 to 72. Dyed fabrics impregnated with the acetate salts of these condensates showed varied degrees of softness and resistance to scorching; however, in all cases, the effect on light fastness was the same. Based on this series, it was felt that the fatty acid portion of the molecule was not the significant factor.

Various organic amines were examined for fading properties when applied to fabric dyed with direct dyes. Samples of cloth were impregnated with 1 per cent solutions of amines containing from one to five nitrogens, centrifuged and ironed dry, followed by forty hours' exposure in a standard Fade-o-Meter. Results obtained were not satisfactory, and no correlation between structure and fading could be drawn. In general, as the number of nitrogens increased, fading tendencies increased, but exceptions could be found. However, it was noticed that whenever salts of the

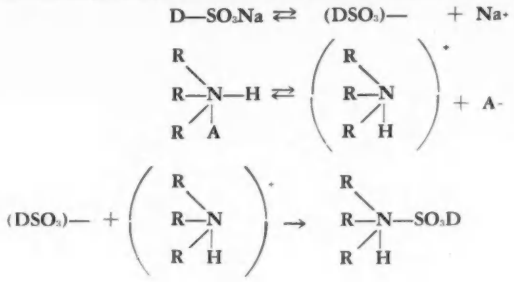

Figure 1

amines, such as the acetate salt of ethylene diamine, were formed, fading tendencies were worse.

In considering the effect of cationic fatty amides on the light fastness properties of dyestuffs, it was felt that the formation of an oil-soluble dye, a class noted for poor light fastness, could be the cause of this defect. This can be shown by the equation (Figure 1), representing the formation of an oil-soluble color through interaction with a compound containing a pentavalent nitrogen in which D is the large organic dyestuff complex carrying the sulfonic acid group. The pentavalent nitrogen or quaternary compound is indicated as carrying three substitutent organic radicals (R) and a hydrogen, which latter arises from the solubilizing acid. The other radical indicated by A hooked to the pentavalent nitrogen arises from the solubilizing acid, which, for instance, may be acetic acid, in which case A is an acetate radical. That the last reaction does occur, can readily be seen when solutions of direct dyestuff and cation active materials are mixed, as there is an immediate co-precipitation resulting in the formation of a new dyestuff which is oil soluble. Oil-soluble dyes, in general, have always been noted for very poor light fastness. That this reaction does not occur with anionic-type fatty amide salts can be ascribed to the fact that the anionic compound ionizes to give a large molecular weight negatively charged ion which does not have any affinity for the similarly charged ion of the dyestuff being used. The nature of the original dyestuff is, therefore, preserved.

Based on the above theory that an oil-soluble dyestuff is produced through interaction with a fatty amide containing a pentavalent nitrogen, a complete study of various types of amides was made. In every case, when a fatty amide was converted to a soluble quaternary compound by treatment with organic acids, such as acetic, lactic, etc., or alkylating agents represented by diethyl or dimethyl sulfate, subsequent Fade-o-Meter tests showed that the light fastness of the dyestuff tested was reduced by the compound prepared. As low as .1 per cent of the fatty amide was suffiicent to cause fading after twenty hours' exposure. This result was particularly noticeable in direct dyes, and to a lesser extent with vats, Rapidogens and Indigosols. As previous tests to completely eliminate the fading of a dyestuff by amines or their salts did not indicate much success, attention was turned to the amide as a whole. Numerous amide bases were prepared in which the fatty acid portion was varied from C_8 to C_{18} and the number of nitrogens in the organic amine ranging from one to five. These series of amides were then further reacted with urea to increase the number of nitrogens in the unit molecule. During condensation with urea, ammonia is formed and the molecular weight of the amide doubled. Both the simple amides and the carbamides were studied with regard to their affect on light fastness of dyes. As acid salts or alkylated compounds, all of the products adversely affected the light fastness of the dyestuff tested. For example, a fabric dyed with Diphenyl Blue Green BL,[5] a direct dyestuff which is satisfactory after forty hours' Fade-o-Meter exposure, when impregnated with ¼%-½% solution of the above amide or substituted amides, shows fading readily. At the end of forty hours almost complete fading is observed.

In view of the fact that variations in both the fatty acids and the organic amides used did not show any marked change in the affect of the amide salt on the light fastness of the dyestuff, it was felt that possibly a side reaction occurred during condensation. Accordingly, two series of amides, one representing a simple amide, such as the condensate of oleic acid and diethylene triamine, and the second, in which the primary and secondary nitrogens have further been reacted with urea to give a carbamate derivative, were prepared. The condensates obtained by heating the fatty acids and amines in equimolar quantities to 190-200°C. were purified by recrystallizing from acetone before making aqueous pastes for impregnation on dyed fabric. The purified compounds as acid or alkylated salts behaved similarly to the semi-crude materials. A series of tests were then made, dissolving the water-insoluble amide in solvent, in order to determine whether the amide itself before alkylation or conversion to an acid salt, adversely affected the light fastness. A 1% solution in acetone was used to impregnate the cloth previously dyed with Diphenyl Blue Green BL[5], approximately 1% amide remaining on the cloth. No fading was observed after forty hours' Fade-o-Meter exposure. In other words, a product containing three valent nitrogens did not cause fading, but preserved the dyestuff with a respect to its light fastness. No increase in light fastness was observed.

In view of the fact that all amides of the types discussed above are water insoluble, except when in the form of their acetate salts or alkylated products, in which form they adversely affect light fastness of dyestuffs, some method of making them water soluble without formation of a quaternary compound became necessary. Various types of emulsifiers proved unsatisfactory, emulsions being obtained which were stable for relatively short periods of time only. In simple amides, such as stearamide or lauramide, the hydrogens attached to the nitrogen are basic, but as the nitrogen portion of the compound is lengthened to form a polyamide, the hydrogens attached to the nitrogens tend to be weakly acidic: in other words, the compound becomes amphoteric. By treating complex polyamides with strong solutions of sodium or potassium hydroxide, the weakly acidic hydrogen is replaced by an alkali metal. These alkali metal salts are water soluble at the boil, and forty-hour Fade-o-Meter tests proved that these sats did not have any affect on the light fastness of direct dyes. It is possible to prepare ammonium or organic amine salts, but the length of the fatty acid chain has to be reduced, and the final softening value of the compound drops off rapidly. Also, when organic bases such as diethylene triamine are used, the resultant products cause fading to some degree.

The products formed by treatment of a high molecular weight fatty amide or carbamide with alkali are substantive by virtue of their nitrogen content and have a pH of 10.5-10.8, as compared to 4.0-5.0 for the well-known cationic-type softeners. No quaternary nitrogens are present, and titration indicates that there is no free alkali. This change in pH has no affect on the substantivity of these compounds for rayon or cotton, as is shown in Figure 2. Here is plotted percent softener on the

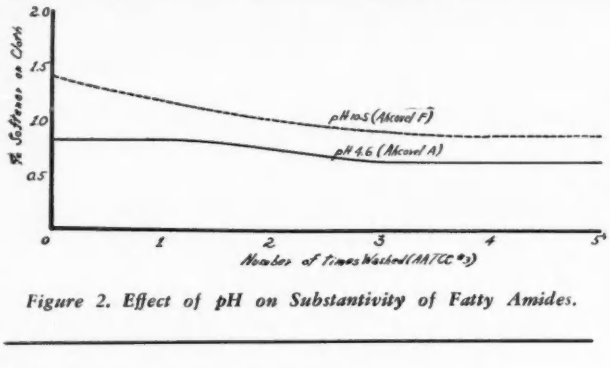

Figure 2. Effect of pH on Substantivity of Fatty Amides.

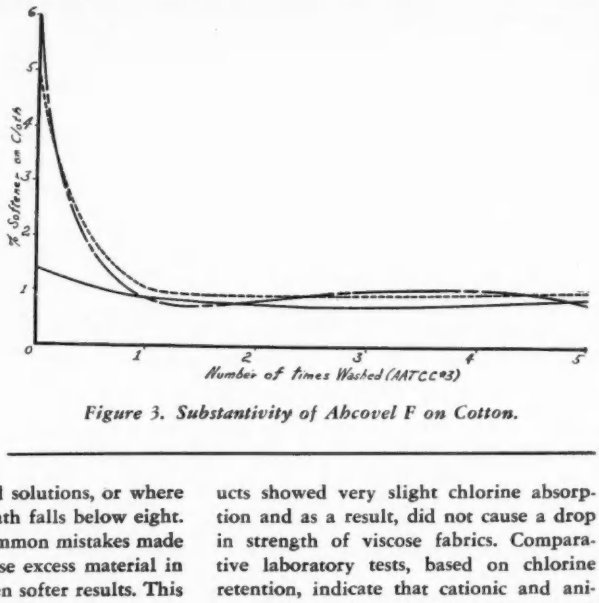

Figure 3. Substantivity of Ahcovel F on Cotton.

fabric, versus the number of times washed, with the AATCC Standard Test No. 3 being used. Ahcovel F, an anionic-type softener with a pH of 10.5, has equal wash resistance as compared to Ahcovel A, a cationic softener. Other cationic softeners available today were checked and gave comparable results. In preparing fabric for testing, 80-square scoured and bleached cotton cloth or similarly prepared rayon fabric was dried to constant weight at 105°C. and impregnated with 1% solutions of the amide being studied. After immersion, the cloth was centrifuged, ironed dry and dried to constant weight at 105°C., the increase in weight being the fatty amide. The pieces were scoured in accordance with the AATCC Test No. 3, rinsed, centrifuged, ironed dry and again dried to constant weight at 105°C. Any loss in weight was recorded after each washing. Blanks run by impregnating similar pieces of cloth with compounds known to be non-substantive showed complete loss after one washing. As shown on Figure 2, there is a slight initial decrease caused by loss of excess surface material, which levels off to around 1% retained by the fabric. While the anionic type appears to be more substantive on the chart, it is felt that for practical purposes, both compounds are equal at the end of the AATCC Test No. 3 washings. Most cationic softeners on the market today have an average molecular weight of 350-450, as compared to the above anionic types, with a molecular weight of 760-900. As would be expected, due to their high molecular weight, these alkali metal salts of fatty amides and carbamides are somewhat more sensitive to salting out, hard water, etc., than lower molecular weight compounds. These disadvantages are more than offset by their advantages, such as greater softening value per unit and better heat stability. One to two hundred parts per million of calcium and magnesium salts are tolerated by the alkali salts of fatty amino and carbamino compounds. Relatively low concentrations of sodium chloride, glauber salt or alkali cause precipitation. None of the salts should be used in acid solutions, or where the pH of the final bath falls below eight.

One of the most common mistakes made by the finisher is to use excess material in an effort to obtain even softer results. This results in wastage of materials and causes a greasy condition on the fabric. As near as can be evaluated in the laboratory, cotton or rayon fabrics will retain from .65% to 1% substantive softener. Regardless of the original concentration, this figure holds, and any amount in excess of this figure is removed in the first washing. In Figure 3, the substantivity of Ahcovel F, a typical anionic softener, is shown on cotton cloth. Similar results are obtained using rayon fabric. In the chart, the percentage softener is plotted against the number of AATCC Test No. 3 washings. After one washing, all samples, regardless of the initial amount of softener retained, were equal with respect to softness and quantity of amide remaining on the cloth. The cloth being tested was dried to constant weight at 105°C. after each washing. Here again, a blank run on a cloth impregnated with a known non-substantive material gave zero retention after one wash.

During the development of these anionic substantive softeners, considerable emphasis was placed on discovering what caused yellowing in cationic-type compounds, in order that this difficulty could be eliminated. It was found that the presence of primary, and to a lesser extent, secondary amino groups, caused yellowing of the compound under heat. During formation of the substituted carbamides, these groups are reacted and all primary, and most all of the secondary amines, are converted to tertiary amines. Exposures of thirty seconds at 400°-425° F. show practically no tendency to scorch, as compared to the degree of scorching for non-substituted amides. In addition to better heat stability, completely substituted products showed very slight chlorine absorption and as a result, did not cause a drop in strength of viscose fabrics. Comparative laboratory tests, based on chlorine retention, indicate that cationic and anionic softeners in which the primary and secondary amino groups have been eliminated cause less loss in strength of viscose fabrics when subjected to laundry conditions containing bleach. These tests were carried out as described by Dr. Walter Stump of American Viscose Corporation.[6] This work indicates that softeners of this type can be used as plasticizers for urea formaldehyde resins without adverse effects.

During the past two or three years, much attention has been directed to atmospheric fading of acetate dyes. Most of the compounds used to correct this difficulty have had an alkali reserve to offset acidity met under normal conditions. Dress goods or coat linings dyed with certain acetate dyes will fade or change color very rapidly, even when kept in a dark closet. Anti-fume agents cannot be used with acidic materials, as they destroy their effectiveness against atmospheric fading. However, anionic products are compatible, and the series of potassium or sodium salts of fatty amides developed in this work are compatible. No change in shade of the dyed fabric is noticed, and tests made show that the compound is not only substantive, but a useful adjunct to the anti-fume product, thus adding protection to the fabric.

Application of "anionics" versus "cationics" is similar, with the exception that in preparing a satisfactory solution of an anionic substantive softener, such as Ahcovel F, care should be taken to bring the bath to the boil. Normally, a concentrated stock solution containing 5%-10% softener is prepared from which any desired strength may be made. Fabrics may be impregnated in the usual padder or in

a dye-beck, where exhaustion is nearly complete. In the dye-beck, very low concentrations may be used, as low as 1.5lbs. per 1500 yards of fabric giving a very pleasant soft drape. When applied at the padder, approximately a 1% solution is necessary for adequate softening. Carry-over of salts from the dyeing operation will precipitate the high molecular weight softeners; consequently, all cloths should be given a thorough wash before finishing, to insure best results. Anionic substantive softeners will not alter the final shade of dyed fabrics and will preserve the resistance to fading of the particular dye used.

Laboratory and plant trials have shown that this series of anionic softeners (Ahcovels E, F and R) find use as pure finishes; as plasticizers for starches, resins and resin emulsions, such as polyvinyl acetate; as softeners in conjunction with anti-fume products: in general, where ultimate softness is required, along with light fastness. Where a soft drapy "hand" alone is required, these products may be used to replace sulfated tallow, under which circumstances, approximately 1 lb. of anionic softener will equal 10 lbs.-11 lbs. of 25% sulfated tallow. No appreciable bodying effect is obtained, however, and it is necessary to incorporate weighters along with the softener.

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Discussion

Dr. Fourt: You have spoken several times of the amount of softness produced per unit weight of material, and I am curious to know in what units one measures softness. When you demonstrate by weight measurements that the substantive materials remain in the fabric through a series of washes, do you also know that the degree of softening obtained remains constant?

Mr. McLeod: Normally, in the laboratory we test the softness on a pound for pound basis, not only against stearic acid softeners but other compounds. They may either be evaluated on a weight basis, in which case we generally analyze to see that the per cent actives are the same, or they can be evaluated on a money value basis. Most of the compounds we have been discussing today contain about 30% to 35% active ingredients. The evaluation of all of the amides which we made in the laboratory was on a weight basis of active material. In the laundry tests, the softness data was comparative. After the first laundry operation there was a drop, showing that the excess material had been removed, as would be expected. From then on, the softness of the fabric remained about the same. I would say that after fifteen laundry operations you begin to notice a decrease, although it never goes back as far as the original fabric is concerned.

Dr. Fourt: I think one point is still a little obscure. Perhaps we all know what softness means. I say sometimes that this fabric is soft and that fabric is hard. But do you have any means of measuring whether a fabric is hard or soft.

Mr. McLeod: The Bureau of Standards has developed an instrument which measures the degree of softness or drape. I believe that on that instrument the fabric is put between springs and the amount of work necessary on the fabric to bend it through an angle of 90 degrees is measured, and from that you are able to evaluate degrees of softness. We do not have one of those instruments at the present time, although we did have one at some time in the past. That instrument, by the way, is very good. When we ran trials in the mill, one of the men, just by picking up the fabric said, "This one is softer than the other." I was unable to pick up that differential. We took the fabric back, ran it on the machine developed by the Bureau of Standards, and it substantiated his ideas in judging by hand. I believe that it is manufactured by the American Instrument Company.

Mr. Fourt: That's correct. It is Dr. Shafer's Flexometer. We have used it and it is an excellent instrument. But, in general, your evaluations to which you have referred here have been judgments from handling. Is that correct?

Mr. McLeod: As far as the washes are concerned, yes. In the initial work, we depended upon the Bureau of Standard's instrument, the Shafer Flexometer.

Mr. Shapiro: In the slides you just showed us on the lightfastness of dyeings after treating with cationic and anionic softeners, were those the same materials as in the previous slides, or were they an entirely different type?

Mr. McLeod: The basic amide in either instance was the same. The only difference is that one was the acid salt and the other the potassium salt.

Mr. Souther: Getting back to Dr. Fourt's question, I would like to ask him if he would care to commit himself as to what he thinks is the best instrument for evaluating softness.

Dr. Fourt: Mr. Chairman, do I have your permission?

Chairman Wille: You certainly have.

Dr. Fourt: I think Mr. Souther is kind of putting me on the spot, because I just made a talk earlier this afternoon on the same lines. We have used in our laboratory—we persuaded the American Instrument Company to start manufacturing—Shafer's Flexometers in order that we might get one. We have found them very useful. Several people have asked me what I thought about them and I have always said I thought it a very good instrument. We ourselves have turned to a slightly different method for convenience or because we had a somewhat different purpose in mind. There are numerous instruments and I am not prepared to say which is best. It would depend on the type of fabric you are dealing with, whether with relatively light fabrics or relatively heavy fabrics. For extremely heavy fabrics, perhaps some of the instruments used in metallurgy, or in the paper field for testing softness, would be better. For light fabrics, I think that Shafer's method or some of the other methods which have been described are about equivalent in performance. It is merely a question of simplicity in operation or one's own ability to obtain instruments.

Dr. Klein: I want to ask whether the amount of agent which is left on the cloth was checked by a nitrogen analysis or purely by weight differential.

Mr. McLeod: That was by the weight differential only. In connection with that, several times mills using these have asked for methods of analysis, but usually the sample contains something which interferes with the analysis. We have not been able to work out any method of analysis to date that would be accurate.

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EMPLOYMENT REGISTER

This column is open for four insertions per year, per member, without charge. Blanks can be obtained from, and filed with, the Secretary of the Association, Lowell Textile Institute, Lowell, Mass. It is understood that these will be open to inspection by prospective employers, who can obtain further information from the Secretary.

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See applications on page P36.

Non-Cellulosic Fibers Group Meeting—

The Manufacture and Processing of Quality Blended Fabrics*

EMORY A. RICHARDS

Airedale Worsted Mills, Woonsocket, R. I.

FABRICS have influenced our economic and social structure ever since man first fabricated cloth to protect himself and to flatter his ego. As time went on and development took place, man learned to enhance the serviceability and beauty of material by spinning, weaving and dyeing. Eventually, by the use of color effects in yarn, combination of weaves and finally thru the use of multi-fiber combinations, he was able to produce more pleasing and desirable material.

The world of fabrics is essential and vital to everyone. From the wildest aborigines who used weeds and grasses to construct their fabrics, to our civilized world, where the art has reached a high degree of refinement, the value of fabrics is well recognized. We have learned to use texture and color to express our personalities in dress and in the home. Thru the medium of fibers, yarns, weave and finish, man protects himself efficiently and properly from the ravages of the elements. In dyeing and printing we use color to brighten our lives and by producing soft, absorbent and sterilized material, we can help the sick and wounded and prevent the spread of disease through the world. Truly, our fabrics today have traveled a historically long and arduous journey from their prehistoric simplicity and utility, to a vast business of men and machines. The textile industry as it now stands is one of America's greatest.

Blended Fabrics

A brief discussion of the term "blended fabrics" should at this point be enlightening. Most of the definitions and interpretations set forth are more from personal experience and practice than on theory. The term "blended fabrics" as used in the trade, generally refers to material containing wool in admixture with rayon, cotton, acetate or nylon. In the majority of cases any one of the above fibers is blended with wool but in some instances combinations of fibers are used to produce fabrics of different hand and also for novelty effects. The combinations finding the greatest use are those of rayon and wool, cotton and wool and rayon, cotton and wool. Again mixtures of 30%-40% and 50% of wool with 70%-60% and 50% of either rayon or cotton enjoy the greatest popularity in the trade, at this time.

Blended fabrics are not new but it is only in the last 8 to 10 years that they have received the greatest attention. As a result of the presence of wool in these fabrics they have been sold more or less in direct competition with all worsted material but mostly as substitutes. This placed a terrific burden on sales organizations as down through the years many persons had formed the opinion that the best material money could buy was all worsted material. Any deviation from 100% wool goods was immediately treated with the feeling that such material was inferior in quality and therefore, not desirable. No attempt was made to properly evaluate these fabrics. Until recently, little effort was put forth by manufacturers to dispel this impression with the result that blended fabrics have been tainted with a stigma of low quality substitute merchandise.

The opportunity to dispel this impression presented itself during the last war. This was brought about in great part by restrictions placed on the use of grease wool and tremendous government commitments for all worsted fabrics. Blended fabrics were immediately in greater demand than ever before, resulting in ever increasing amounts of material produced. During this period blended fabrics were used for many purposes—to name a few: top-coatings, slacks, sport clothes, shoe cloths and suitings. In many cases, garments made from this material were superior in some respects to the all wool garments, such as water repellency, resistance to abrasion, shrinkage, etc. However, as soon as the war ended and the worsted industry was able to revert to prewar production schedules, the demand for so-called substitute fabrics was greatly reduced. There is, however, a definite need and market for quality blended fabrics, those that will stand and sell on their own merits and with the proper approach a continuous demand can be created for a fabric of this type in the higher priced field.

Raw Materials

As in all industries, the textile industry requires the selection of raw materials meeting the most rigid specifications, both physical and chemical, to produce finished products of the highest quality. Since wool, cotton and rayon are used most frequently in blended fabrics, this paper will be limited to these three fibers. They fall into two general classifications, wool and cotton are natural fibers, while rayon is a man made or synthetic fiber.

Every fabric is a mixture. Each wool fabric combines fibers from many fleeces, cotton fabrics contain fibers from numerous cotton plants and rayon fabrics are made from filaments obtained from many different batches. It takes highly technical knowledge to skillfully blend and mix these individual fibers and filaments, and yet, to mix the fibers and filaments with each other is even more difficult. A glimpse of the extent of skill needed to blend and combine fibers makes one realize the purpose and personality of each fabric.

Fine wool is grown on sheep, bred expressly for wool production. The fleece of these sheep completely covers the body, grows very dense (there being as many as 200,000 fibers per square inch) and has a high dirt and grease content averaging 50% to 60% of its weight. The fiber varies from ½" to 5" length, while the diameter will run from 17 to 23 microns. The chemical composition also varies, due to unequal exposure to the elements and the natural habits of the sheep. One troublesome factor is the limited quantities of wool produced by each sheep and the fact that the wool will vary in quality from fleece to fleece and also in each fleece. In order to overcome this variation, the individual fleeces should be

* Presented at Non-Cellulosic Fibers Group Meeting, Robert C. Anderson, Presiding, National Convention, Chicago, October 24, 1947.

sorted by hand, the fine wools being segregated from the coarse and the foreign matter removed as much as possible. Complete segregation is impossible, so that in each lot there exists considerable variation in physical and chemical constants. In order to reduce the troublesome effects that would result when using small quantities, it is well to blend a large number of fleeces together.

The cotton fiber is termed a vegetable fiber and is dependent on the whims of nature. It is a well known fact that the cotton plant readily responds to changes in soil, climate and cultivation. Even though it is directly affected by nature this factor is not too troublesome, since large acreage can be planted that will yield material having the same characteristics, both chemical and physical. At present, there are approximately some fifty recognized species of the plant but of these only five or six are of commercial value. A great deal of the cotton used in the United States today, can be roughly classed under two distinct types, Upland and Egyptian. The Upland grade is medium in diameter and length, averaging slightly over 1" in staple length and from 15 to 20 microns in diameter. It is usually white in color with a tendency toward the creamy. The Egyptian cottons are longer, averaging 1⅜" in staple, strong and silky and slightly brown in color. For blending, cottons having an average staple length of 1 3/16" are better than the shorter cottons. They yield blends more consistent in fiber distribution and a better grade of yarn. Again as with wool, all foreign matter should be removed as much as possible.

Rayon is presently enjoying the greatest popularity for use in blended fabrics. The two types generally accepted are the viscose and acetate rayons, with a decided emphasis on the viscose type. Many desired fabrics have been made from blends of wool and acetate but as yet have not been in as great demand as the wool-viscose type but as time goes on they will, no doubt, find greater usage. When blending viscose rayon with wool the fiber should be completely delustered, approximately 1½" in staple length and either 1½ or 3 denier in size depending on the fabric to be manufactured. It is well to bear in mind that lustrous rayon imparts a high degree of sheen to a fabric, which presently is not desirable in blended fabrics. This necessitates delustering after dyeing, a very tricky and at best, haphazard procedure.

Control and Specifications

As stated earlier, the manufacturer of blended fabrics is confronted with more problems than those who use only one kind of fiber but when producing fabrics of the highest quality the slightest deviation from rigid control and specifications will result in intensifying all these problems and troubles. Careful control and constant supervision are of the essence and if not applied at all times will be immediately reflected in the quality of the finished material.

In blending various kinds of fibers the physical constants such as shape, outer structure, density and staple length, should be investigated thoroughly. These factors will affect the evenness of fiber distribution, the strength of yarn produced and may cause all kinds of trouble during weaving and finishing. Little can be done later on to correct faults caused by uneven fiber distribution. From the chemical side the selective absorption of dyestuff by each kind of fiber, as well as of each individual lot used, should be determined. This is sometimes called the dye index number. Variations existing in all types of fibers, either natural or synthetic, make it important to check each lot for its dye index. In fabrics that are unevenly dyed or motley in appearance, the cause can frequently be traced to the use of lots of fibers having different dyeing indices.

The processes of opening, picking and blending are quite well standardized from the mechanical viewpoint. The number of operations necessary to assure proper blending is controversial and has been the subject of much discussion; however, most manufacturers feel that a minimum of eight operations are necessary. During the process of opening, picking and blending care should be taken not to over-load the machines as this could result in improper opening of stock and uneven blending of fibers. The use of a static inhibitor has proved beneficial since the elimination of static electricity allows the fibers to lay flat, resulting in better control at all times. It also yields longer lap lengths from the pickers and a good even sliver from the cards, both desirable from the quality and production angle.

In order to produce a nice even yarn of the highest quality, constant testing should be applied to determine the oil and grease content of the wool-top before mixing with the cotton or rayon. The consensus of opinion, until recently, has been that a dry combed top was essential for use in blended fabrics. However, it has been found that oil combed top can be used to better advantage. This may be due, in part, to the use of mineral oil blends instead of olive oil and also to the fact that most wool-top now used is not allowed to age. Cotton and rayon are fairly constant and do not require too much attention from this angle.

The practice of using sighting colors for the identification of different blends of fibers is frequently the source of considable trouble during wet-finishing and dyeing. This can be traced to the use of improper types, excessive amounts of coloring matter and to uneven distribution of sighting color through the blend. Colors having no substantivity to either natural or synthetic fibers are ideal and certain types of micro-powders fill this requirement; however, they lack tinctorial power and are very difficult to keep in suspension. Acid colors are most widely used, having good coloring power, being easily dissolved in water and are fairly low in cost. Their affinity for wool is great and if subjected to moist heat such as steam, it becomes necessary to use stripping agents for complete removal. When dyeing light, clear shades the presence of the smallest amount of sighting color will cause dulling of the shade and sometimes uneven dyeing. Therefore, care should be exercised when selecting the colors and amounts to be used.

The intricacies of yarn manufacturing and weaving are beyond the scope of this paper. Suffice to say that the greater portion of blended yarns are spun on the long draft or cotton system but can and are also spun on the worsted or Bradford system. Imperfections made during spinning and while weaving, such as slubs, unevenness, low tensile strength in yarn and broken ends, ready goods, side lines and rowy filling in the fabric are very difficult to correct, therefore, it is necessary to supervise these operations closely.

Scouring, Dyeing and Finishing

The scouring, dyeing and finishing of fabrics present fields of endeavor where every individual concerned has definite ideas on how it should be done. I do not wish to state which is the best way but want to touch on some methods now being used.

The primary requisites for good scouring are:

1. A thorough knowledge of water conditions.
2. Machines large enough not to crowd the pieces.
3. Scouring agents meeting all requirements at hand.
4. Complete removal of scouring assistants.

The removal of sizing material has always been a bothersome procedure requiring special assistants and additional processing time. Recently, new developments in the sizing field have produced water soluble sizes readily adaptable to blended fabrics. One great advantage in using these sizes is the fact that they

do not require desizing agents for removal. Complete removal can be accomplished by water at 120°-140° F., simultaneously with the scouring, thus saving time and money.

We have found that synthetic detergents, properly buffered, give us the best all around results. Care should be taken not to use excessive quantities of alkalis as they can cause much trouble during dyeing. This condition is more pronounced in the so-called cotton-worsted, where a worsted warp is filled with a cotton filling. A peculiar condition developed in our plant where pieces from the same loom, scoured, dyed and finished at the same time, showed a variance in shade. A complete investigation indicated that high concentrations of alkali were aggravating this condition and only by reducing these could we eliminate this trouble. The fact that we use synthetics with complete satisfaction should in no way be construed to mean that soap is not satisfactory, as many plants are using it with excellent results. However, for our particular water conditions, raw materials used and hand desired, synthetics are desirable.

The successful dyeing of blended fabrics demand a thorough knowledge of the chemical and physical properties of the dyestuffs and fibers. Many different methods are used but the two most commonly practiced are the union and vat processes. In the past, the application of vat colors to blends was not practiced too extensively because of the presence of wool and the fact that they required special apparatus and methods. Recently, new dyeing technics have eliminated some of the undesirable factors, making this class of colors available for use on blends. Since vat colors yield the best possible fastness properties they will readily be accepted as soon as further research and developments take place.

In the past, most dyers used the union method because of the ease of application and the fact that there was no damaging effects on the fabric. Even though colors having the maximum fastness to light, perspiration, water and crocking were used, the ultimate shade was still lacking in some respects but were accepted by the trade. Concerning the substantivity of dyestuffs, many are of the opinion that it is advantageous to use colors that will dye individual fibers only, since they feel that it simplifies the matching process and in many cases produces faster shades. The dyeing process finds many variations in practice but the critical points are the same regardless of the procedure used. A resume of these points includes the following:

1. Solubility of dyestuff.
2. Initial starting temperature.
3. Water ratio to cloth.
4. Rate of rise to maximum temperature.
5. Optimum dyeing temperature.

Careful control and supervision of these points should produce constant results and with correct combinations of colors should yield the fastest possible shades. It is well to bear in mind, that the use of automatic controls should be instituted as much as possible as these will eliminate the troublesome factor of human error.

The mechanical finishing of blends does not require too much handling. A clear smooth finish, devoid of any sheen is essential and can be accomplished by shearing or singeing, steaming and in some cases a light pressing.

The introduction of semi-permanent chemical finishes applicable to blends of wool, rayon and cotton has opened new fields for blended fabrics. Some of these chemicals not only give the fabric a very desirable hand and appearance but in some cases tend to increase certain fastness properties of the colors applied. An example of this is the increased fastness to washing of direct colors when treated with a resin. There are, however, some undesirable effects produced such as embrittlement of fibers, decrease in tensile strength and decreased light fastness when these same resins are used. These problems are not insurmountable and can be solved or at least minimized by continued research. Many advantages have been derived by the application of these finishes; some of these are: excellent water repellency, increased resistance to abrasion, shrinkage control in laundering and a semi-permanent crisp hand.

Finally, good styling, sharp clear colors and high quality are necessary to assure a continuous and increasing demand for blended fabrics.

Discussion

Dr. Milton Harris: I'd like to ask whether, in making blended fabrics, there are any particular laws which govern the blends, that is, do you evaluate them in terms of given uses or do you arbitrarily take so much cotton, so much rayon and so much wool and decide that that is a pretty good fabric?

Mr. Richards: There are no particular laws or rules. The trade presently favors a blend of forty percent wool and sixty percent rayon. As regards the serviceability of that fabric, there isn't much that we can do. We generally follow the demands of the trade.

Dr. Harris: Is it something someone developed?

Mr. Richards: It seems best for all-around uses, especially hand. It governs the sale of the fabric. If you get beyond a certain point in the ratio of wool to rayon, it gets spongy. It doesn't have the hand or the crispness that it should have.

Mr. Hale: Where does cost come into the picture and what has the trade decided?

Mr. Richards: As I said earlier, blended fabrics, up until recently, had always sold as substitute merchandise. They were always made against a cost. They weren't made for quality. If you were operating a plant and you wanted to keep the wheels turning, you just produced something at a price regardless of what the fabric was.

Mr. Hale: A year or so before the war, a certain price field was desired by the trade to make up a garment. Does that enter into the ratio?

Mr. Richards: Not necessarily. No, I don't think that has much bearing on the ratio of the makeup of the fabric.

Mr. Morrison: In the mechanical finishing, you spoke on light pressing. What is your reaction to decating a blended fabric?

Mr. Richards: Are you talking now about the desirable effects from decating?

Mr. Morrison: Yes. Should it be done or shouldn't it be done?

Mr. Richards: We feel it isn't necessary because the trade doesn't demand it.

Mr. Morrison: There would be no advantage in decating for the hand that you talk about?

Mr. Richards: No. The hand has to be chemically finished. We can't get hand mechanically as we do with an all worsted fabric.

EMPLOYMENT REGISTER

47-39

Education: B.T.C., Lowell Textile Institute, 1936.

Experience: Textile chemist, operator of dyeing and finishing equipment, laboratory manager and inspector, manager of dyeing plant.

Age, 35; married, references.

47-40

Education: B.S., Rensselaer Polytechnic Institute; M.A., Columbia.

Experience: Organic chemist, petroleum inspector in Army of U.S., dyehouse chemist, formulation and testing of textile specialties.

Age 35; married; references; position in northeast U.S. desired.

SEE PAGE P33

LOUIS A. OLNEY, Sc.D.
Directing Editor

AMERICAN
DYESTUFF REPORTER

NORMAN A. JOHNSON, B.T.C.
Managing Editor

JANUARY 12, 1948

Cooperation Between Mills and Dyestuff Manufacturers

AS in many other industries there are, at the present time, shortages in certain items that are used in the textile industry including dyestuffs, chemicals, yarns, grey goods, etc. As develops under such circumstances, items which are short in supply find their way into speculative markets where the price increases tremendously. As regards the dyestuff shortages which occur there are a number of ways in which mill owners can cooperate to a great extent with dyestuff manufacturers to minimize the effect of shortages of certain items and eliminate a secondary market.

Since before the war the dyestuff manufacturers have had no opportunity to build stock piles of the numerous items which they must furnish to the textile mills and their inventories are necessarily small. Accordingly, if a consumer should increase consumption of certain items by 10, 20 or 30 times without sufficient advance notice it is impossible for the manufacturer to fill the order. The manufacturer has to schedule his operations so far in advance that he cannot immediately fill a demand which has increased all out of proportion to his supply of intermediates available. This is a situation in which all sections of the textile industry can help the dyestuff manufacturer foresee far enough in advance the demands that will be made upon his resources. A great many shortages in the textile industry are caused by a lack of planning in the style seasons. In other words there will have to be cooperation right at the beginning, including styling, designing, etc. It will call for considerable group thinking and planning well in advance of the time when the demands will be made on the dyestuff manufacturer.

Another instance in which the textile mills can cooperate with the dyestuff manufacturers is by eliminating a secondary market in dyestuffs. It is reported that certain mills have resold dyes to the so-called black market, which dyes are again resold at exorbitant prices and frequently exported. We feel that textile mills have a very real moral obligation to cooperate in the elimination of a black market in dyestuffs. Mills which act to further the interests of the black market are certainly doing no favor to themselves by creating artificially high prices for certain items.

Once a dyestuff becomes a part of the black market the manufacturer loses all control over it. It may be sold a number of times, each time at a higher price. It may be adulterated but still sold as the original product under the manufacturer's name. Such practices will invariably reflect upon the good name of the American dyestuff manufacturers and will cause a feeling of ill will toward them on the part of the foreign mills who have purchased the black market dyestuffs.

It is further particularly embarrassing for a dyestuff manufacturer to have to refuse certain of his items to a customer because of their scarcity and then have them offered to them, at a higher price, from another source.

Calco Chemical Division of American Cyanamid Company has taken a constructive step forward to clear up this situation by informing their customers in the textile, leather, paper and plastic manufacturing industries that, if they purchase dyes for resale to the black market instead of for their own consumption, Calco will take immediate action. Referring to this matter in a letter to their customers, J. Pfister, Manager of Calco's Dyestuff Department, writes, in part:

"It has been brought to our attention that certain mills are selling dyes to the so-called black market, which dyes are resold at exorbitant prices and usually exported. We are certain that no responsible American dyestuff manufacturer is a party to supplying a black market with his products and such supplies, we are sorry to say, come mostly from mills who abuse the confidence of the dyestuff manufacturer. For consumers to order dyes for the purpose of resale to black markets is not only a breach of contract but a breach of good faith* * * *.

"There is undoubtedly a responsibility on the part of the American dyestuff industry to assist as much as possible in the rehabilitation of business in a number of foreign countries which, because of the world situation, find themselves entirely without dyes. However, such exports must be kept in bounds *and should not be via black markets.*"

It is further pointed out in the letter that it is not believed there will be at any time a general shortage of dyes, such shortages as there may be being confined largely to particular dyes and special types, due principally to scarcities of special intermediates. It is indicated that there need be no alarm that our domestic dye-consuming industries will lack sufficient coloring matter to carry on.

We are certain that the number of mills who have engaged in the practice of reselling dyestuffs to a secondary market is but a small percentage of the total but, by withdrawing the dyestuffs from the legitimate domestic market, they are doing harm to all our dyestuff consuming mills. Our advice to textile mills who do resell dyestuffs is to stop at once for the good of the industry. The dyestuff manufacturers are doing all in their power to adequately supply all domestic consumers with their fair share of scarce items. Please cooperate with them by accepting only those dyestuffs which you will use in your own mill. We are certain that fair-minded mill executives will see the folly of supporting a black market and take steps to make sure that such practices are not going on in *their* plants. Textile mills in this country have a big enough job to do without going into the dyestuff business as a side line.

Any type of black market has a bad effect on the country as a whole, creates fictitious shortages and destroys the integrity of the employee. Let us all assume a policy of cooperation that will eliminate any unnecessary shortages and deliver us from this evil.

TRADE NOTES • NEW PRODUCTS

• General Releases

General Dyestuff Corp., 435 Hudson Street, New York 14, N. Y., announces release of circulars describing the following products:

*Rapidogen*Blue PBN* (Patented)—an azoic compound soluble in caustic soda which after printing and acid ageing develops in the form of an insoluble pigment said to possess good fastness. When printed on cotton or rayon fabrics it produces in heavy and light concentrations desirable shades said to possess good fastness to washing and fairly good fastness to light and chlorine. It has the additional advantage that even when printed in light shades it is not subject to variations in shade when soaped at the boil in rope form or in high speed open soaping. It is applied in the usual manner for Rapidogen colors. The stability in the print paste is good and the shade develops completely in acid ageing. When dissolved with Developer Base RNA or RPN in place of caustic soda, it develops satisfactorily in neutral ageing and can be printed alongside vat colors. Circular G-498.

Nekal A*—a synthetic surface-active wetting, dispersing, stabilizing and emulsifying agent said to be stable to acid, alkali and heat. It is particularly recommended by the manufacturers for lake preparations and the manufacture of rubber dispersions. It is also used by the textile, leather and paper industries. Being anionic-active, it is incompatible with cationic products such as basic dyes or quaternary ammonium compounds. Aqueous solutions are unaffected by dilute acid or dilute caustic alkali, even at the boil. Circular G-485.

Monopol Brilliant Oils in the Textile Industry—(Monopol Brilliant Oil 48%; Monopol Brilliant Oil 35%)—neutral, specially sulfonated castor oils that are of interest to the textile trade. They are said to be quite different from ordinary sulfonated castor oil in that their solutions are not precipitated immediately by the addition of solutions of calcium salts. It is stated that they are completely soluble and produce water-clear, colorless solutions in any concentration. They do not form insoluble lime soaps in hard water but, on the contrary, dissolve lime soaps to a certain extent. They are said to show excellent stability to acids and alkali, and are unaffected by salts in concentrations encountered in textile processing. It is further stated that they are completely neutralized with soda and produce neutral, permanent, clear solutions that can be boiled without decomposition. Circular G-489.

• Opens Consulting Office

Stanley A. Sokoloff, who has opened new offices at 475 Fifth Avenue, New York, as a textile consultant. Mr. Sokoloff has had considerable experience in this field and will specialize in fabric development and related activities on an expanded basis. During the war he was Materials Engineer in Textiles for the U. S. Maritime Commission. He has also been an instructor in textile technology in the graduate school of the U. S. Department of Agriculture in Washington. In addition to his consulting work, Mr. Sokoloff will continue on the staff of the N. Y. U. School of Retailing, offering a course on fabrics in the evening school.

Soromine BSS Paste* (Patented)—said to be an extremely efficient cationic softening agent belonging to the well known group of quaternary ammonium softening compounds. It is stated that it is highly substantive to cellulosic fibers, exhausts well and is therefore very economical to use. The product is further said to have the property of improving the fastness of direct dyeings to water and perspiration with slight modification of shade and decrease in light fastness. It dissolves readily when stirred in warm water and the solutions are practically neutral and stable to hard water and normal amounts of acids and alkalies. It is best used as an after-treatment, or in the finishing procedure. It is said to give a full, smooth, soft hand difficult to duplicate with other compounds. The softening effect is greatest on cellulosic fibers, particularly spun and filament rayon yarns, crepes and spun fabrics, mercerized cotton yarn and knit goods, acetate fabrics and yarns and mixtures of these fibers. Circular G-496.

Soromine KS*—a substantive type of softening agent with dye-fixing properties. It is claimed that it is so outstanding as a fixative that it must be classified primarily among the dye-fixing agents. It should therefore prove of special interest where fastness to bleeding and/or fastness to perspiration of direct and acid dyes is required, along with a soft full hand. This agent finds its greatest usefulness on fabrics and yarns of spun and filament rayon, acetate rayon and cotton. It is also used for softening casein fibers, nylon, wool, etc., even though fastness to bleeding is not important. Circular G-497.

Peregal TW (Patented)—a correcting agent to overcome the tippy dyeing of wool raw stock. An increase in color value is also observed with the use of this product in the dyeing of piece goods containing mixtures of tippy dyeing wool. It can be used with acid and chrome dyestuffs. Circular G-499.

Appretan NSF Conc.—a non-slip finish for use on loosely woven rayon fabrics. It has the property of binding the warp and filling threads and prevents slippage without materially affecting the hand of the fabric. It is stated that it is very easily applied and can be used either alone or mixed with sizing compounds to produce any desired finish. Circular GDC-278.

* Reg. U. S. Off.

• Bulletin on Vat Dyeing

The textile industry has recently taken a forward step by the introduction of a new process which permits the use of vat dyes in the dyeing of wool. This new development makes available to the wool dyeing industry, for the first time, the use of bright shades with the extreme fastness which hitherto could only be obtained in cotton and rayon fabrics. By reason of the introduction of this new process for the vat dyeing of wool, it is stated that most wool fabrics today can be treated with Lanaset* resin to control shrinkage without impairing fastness properties or brightness of shade. It is reported that these new advances in the technology of wool dyeing and finishing will lead to substantial increases in the use of wool fabrics.

It is stated that much of the development work on the vat dyeing process has been performed by the Calco Textile Sales

Service Department. The new Calco Technical Bulletin No. 797, Vat Dyeing of Wool, outlines the fundamental dyeing procedures.

A copy of this bulletin may be obtained from your Calco representative or by writing the Advertising Department, Calco Chemical Division, American Cyanamid Company, Bound Brook, New Jersey.

* Reg. U. S. Pat. Off.

• Eaton Chemical and Dyestuff Company

Eaton-Clark Company of Detroit, Michigan, with Canadian plants at Windsor and Toronto, has changed its corporate name to Eaton Chemical and Dyestuff Company, as announced by its President, Berrien Eaton. The change became effective January 1, 1948, when the Company celebrated its one hundred and tenth anniversary. Eaton Chemical and Dyestuff Company are manufacturers and distributors of industrial chemicals and aniline dyes.

Business was carried on under the name of Theodore H. Eaton from 1838 through 1865; as Theodore H. Eaton and Son from 1866 to 1910; and as Eaton-Clark Co. from 1911 through 1947.

There has been no recent change in the officers of the company and none is contemplated at this time. Berrien Eaton continues as President and Treasurer. Richard C. Hedke continues as Vice President, Managing Director and Secretary. Rotheus P. Cole continues as Chief Chemist and Manager, Dyestuff Division, Gerald T. McCray continues as Sales Manager, Industrial Chemicals Division; Raymond F. McDonald continues as Sales Manager, Laundry and Dry Cleaning Products Division, and Advertising Manager. Rufus W. Clark, who has been Chairman of the Board since 1921, retired from active business and as a Director a year ago.

• ASA Appoints Vice Admiral Hussey

Vice Admiral George F. Hussey, Jr., USN (Ret.), wartime Chief of the Navy's Bureau of Ordnance, has joined the staff of the American Standards Association and on January 1 assumed the duties as administrative head of that organization. In this capacity Admiral Hussey will continue to serve the nation by directing the cooperative efforts of industry, consumers and government in the vital problem of standardization. Cyril Ainsworth, who for a number of years has been in charge of the technical activities of the ASA, will serve with Vice Admiral Hussey as director of operations of the ASA staff.

Admiral Hussey started his Navy career in 1912 with an appointment to the U. S. Naval Academy, and has served in many capacities requiring the highest order of skill and ability. Specializing in ballistics, Admiral Hussey advanced in grade and responsibility to the position of Chief of Bureau of Ordnance, Navy Department, Washington, D. C. For his service in this capacity he was awarded the Distinguished Service Medal.

In accepting the appointment, Admiral Hussey will take over the tremendously increased administrative responsibilities from Dr. P. G. Agnew, under whose direction the ASA has progressed to its present level. Dr. Agnew, one of the world's foremost authorities on standardization, will continue his service to ASA as Consultant.

• Stationary Mercury Cell

The recently announced stationary mercury cell for the electrolytic production of pure 50% caustic soda developed by The Mathieson Alkali Works, with some changes and improvements contributed by Alcan's engineering staff, is shown above as installed at the Aluminum Company of Canada, Arvida, Quebec.

The long horizontal chamber is the electrolyzer, in which brine is decomposed to form sodium amalgam and chlorine gas. The mercury cathode flows in a sloping channel at the bottom of the chamber; the graphite anodes are suspended from the top at regular intervals. From the electrolyzer the amalgam is transferred, by means of the intervening conical pump, to the top of the vertical decomposing chamber in the foreground. Here the sodium of the amalgam reacts with water, which enters at the bottom and forces its way upward in a very thin film between the amalgam anode and the graphite packing cathode, to form caustic soda and hydrogen gas. The mercury, practically freed of sodium, flows back into the electrolyzer.

The American Standards Association, faced with an unprecedented demand for service to industry, consumer and government expects to increase its activities during the next year to approximately three times that of the largest year before the war. At the present time there are over 366 projects being carried on under ASA procedures with more pending. Projects such as the standardization of women's dress sizes, business methods, and symbols for use in work on supersonic projectiles and airplanes are indicative of the wide range of subjects covered in the many requests for service.

• Joins Industrial Rayon

Louis A. Oberly, formerly Research Director for Hartford Rayon Corp., is now associated with the Research Staff of Industrial Rayon Corp., Cleveland, Ohio.

• Chemical Products Manual

Publication of a new edition of "Chemicals By Glyco," a 92-page manual listing and describing the many organic chemical compounds manufactured by the Glyco Products Company, Inc., has been announced by Harry Bennett, president. Besides listing and describing the complete line of Glyco chemicals, the new edition gives formulae for basic uses of the chemicals. Copies of the new manual may be obtained by writing to the company's main office at 26 Court Street, Brooklyn 2, N. Y.

Several new products are described in the volume. Among them are:

Flovis, a starch gel stabilizer which is said to be finding wide usage in textile, paper and adhesive industries. Flovis, when added to starch in amounts as little as .5 to 2 per cent, based on weight, is said to greatly retard the "set" of starch solutions and keeps the gel more fluid and prevents lumping.

A new wax, *Flexo Wax C Light*, whose adhesive properties is said to make it ideal for use in the screen printing of textiles. The new wax is applied to the printing tables and, because of its special properties, is said to hold fabricates tightly, avoiding smudging due to slipping and completely eliminate the necesity of pinning fabrics. It does not adhere to the material.

Also described in the new 92-page manual are many new uses for products which have been manufactured regularly for some time.

• Fiberglas Textile Division and Laboratory Move

Establishment of the Fiberglas Textile

Division at 16 East 56th Street, New York City, and transfer of the Fiberglas Textile Products Development Laboratory from Newark, Ohio, to the Fiberglas plant at Ashton, Rhode Island, were announced recently by Harold Boeschenstein, President of Owens-Corning Fiberglas Corporation.

Purpose of the moves is to centralize sales, service and development of Fiberglas textile at locations convenient to the textile industry, Mr. Boeschenstein pointed out.

Basic research and development of textile fibers, as well as experimental work in applications of other types of Fiberglas materials, will continue in the company's general research laboratories in Newark, Ohio.

• Sodium Sulfate Electrolysis

A description of sodium sulfate electrolysis with mercury cathodes as carried out experimentally at the Bitterfeld plant of I. G. Farbenindustrie is contained in a report now on sale by the Office of Technical Services, Department of Commerce. The report consists almost entirely of a translation of an I. G. Farben research paper obtained by OTS investigators in Germany.

Orders for the report (PB-34812; *Sodium sulfate electrolysis;* mimeograph, 75 cents; 29 pages) should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C., and should be accompanied by check or money order, payable to the Treasurer of the United States.

Descriptions of other OTS reports on the production of caustic soda with vertical and horizontal chlorine cells in Germany may be obtained from OTS, free of charge, by requesting copies of press releases Nos. 250, 354, 396 and 468.

• New Resin Alcohol

Commercial production of a new low-cost resin alcohol made from rosin, which has potential application in a wide number of industries including textile, rubber, adhesive, detergent, paint, varnish, and lacquer, has been announced by Hercules Powder Company. The new product is called hydroabietyl alcohol. It is the first commercially available primary alcohol to be developed from rosin, one of the cheapest organic acids available.

For many years the published research of laboratories both in America and Europe has disclosed a wide variety of valuable products that may be derived from hydroabietyl alcohol such as: resins, foamers, detergents, wetting agents, emulsifying agents, plasticizers, corrosion inhibitors, antioxidants, parasiticides, bactericides, and compounds highly stable to ultraviolet light. Full investigation of these compounds has awaited the commercial availability of this unique resin alcohol.

Hydroabietyl alcohol can be used without further chemical reaction as a modifier for chlorinated rubber, polyamides, hydrogenated oils, textile sizes, rubber compositions, and essential oil vehicles.

Commercial production of hydroabietyl alcohol will be carried out in a unit of Hercules' new plant at Burlington, New Jersey. This $3,000,000 plant, considered the most modern synthetic resin plant in existence, was designed especially for the production of chemicals derived from rosin.

• Sodium CMC Production To be Expanded

The Du Pont Company is expanding facilities at its Carney's Point, N. J., Works for the production of sodium carboxymethyl cellulose, or Sodium CMC, a versatile chemical compound that is finding a variety of uses in important industries.

While the product is now being manufactured in substantial quantities the new facilities to be completed early in 1948 will be required to meet the anticipated demand. Great emphasis will be placed on the production of technical grades of Sodium CMC to provide a low-priced material suitable for some of the major industrial applications.

• Celanese Transfer

William H. Schnabel, formerly superintendent of the acetic acid unit at the Bishop, Texas, plant of Celanese Corporation of America, has been transferred to the New York office as director of the new technical service department of Celanese Chemical Corporation.

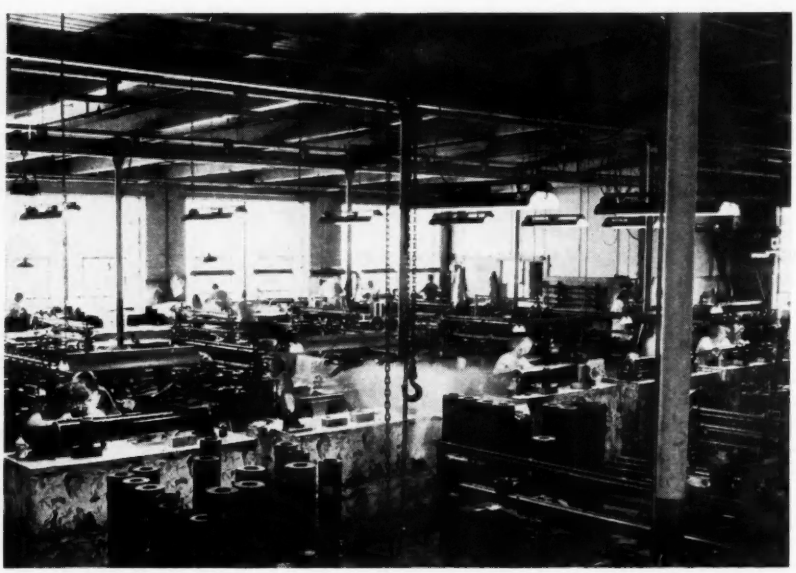
This new department has been established to co-ordinate production quality control with customer needs, to provide customers with technical knowledge in production problems, and to assist in the development of improved methods of handling the production and control of chemicals.

• Engraving Facilities Increased

The Engraving facilities of the Aspinook Corporation have been increased by 50 per cent, it was announced by William A. Broadfoot company president.

Located at the Arnold Print Works, an Aspinook affiliate at Adams, Massachusetts, the engraving department previously produced the engravings only for the needs of the Arnold plant. The acquisition of various plants by Aspinook made the enlargement of the engraving department necessary, and the Arnold plant is now producing engravings for the parent company at Jewett City, Connecticut, its affiliate, the Lawrence Print Works, Inc., at Lawrence, Massachusetts, and the Hampton Print Works, Easthampton, Massachusetts.

The engraving department has been increased in size, personnel and equipment.



Above is a section of the expanded engraving department of the Arnold Print Works, an Aspinook affiliate at Adams, Mass.

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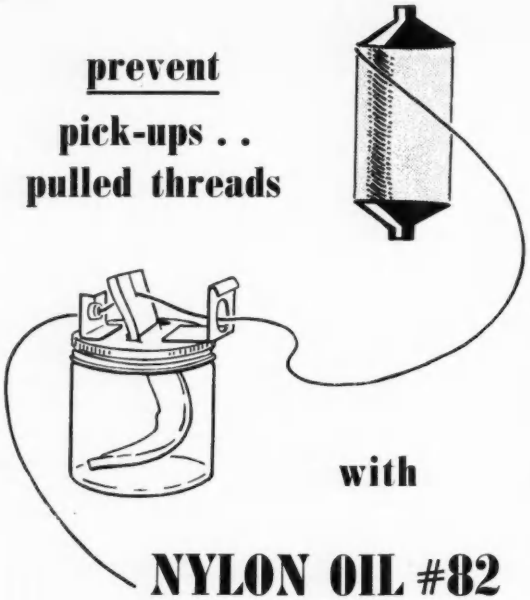

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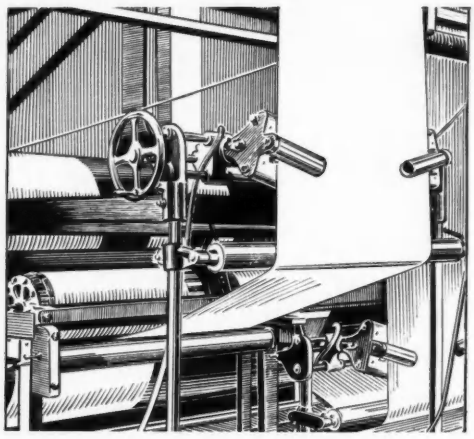

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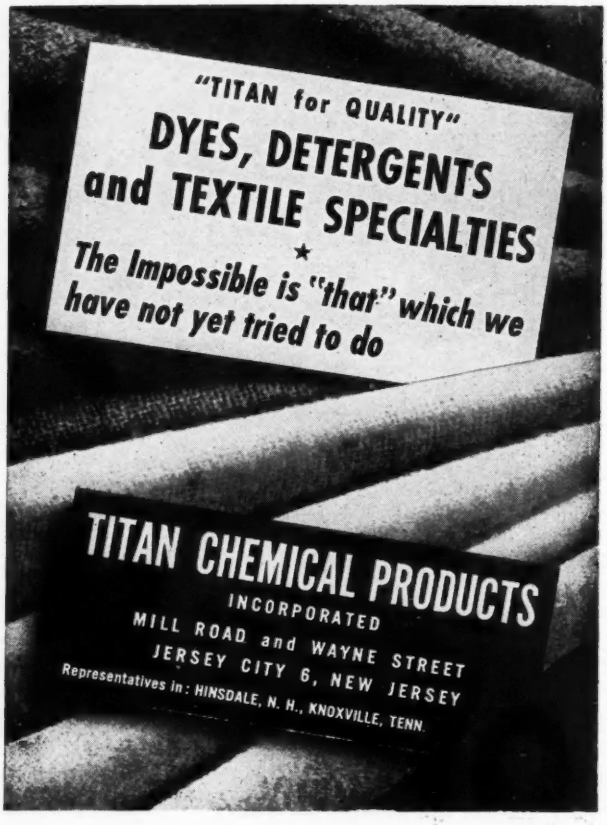
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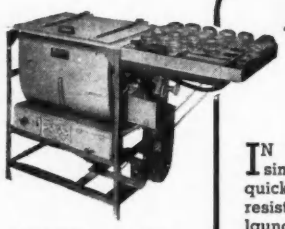

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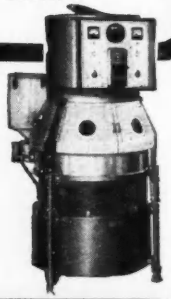

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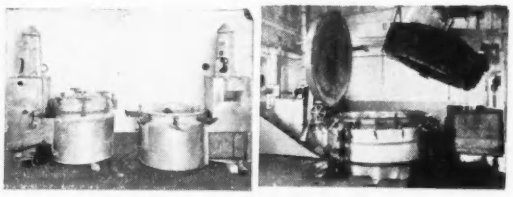

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*ALGEPON V A: Auxiliary used in dyeing vat colors to retard reoxidation of the reduced bath and produce a solid and uniform shade—also effective in stripping vat dyeings.

*CULOFIX: Used as an after treatment in last rinse to prevent bleeding of direct dyed cotton or rayon in water.

*DIAZONOL A C: For boiling out cotton cloth in pressure or open kiers to produce greater absorbency and cleaner material. Excellent for pre-boiling knitted cloth in preparation for chlorine bleach. Also used with good results for boiling out cotton or rayon cloth on the jig.

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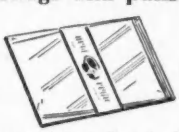

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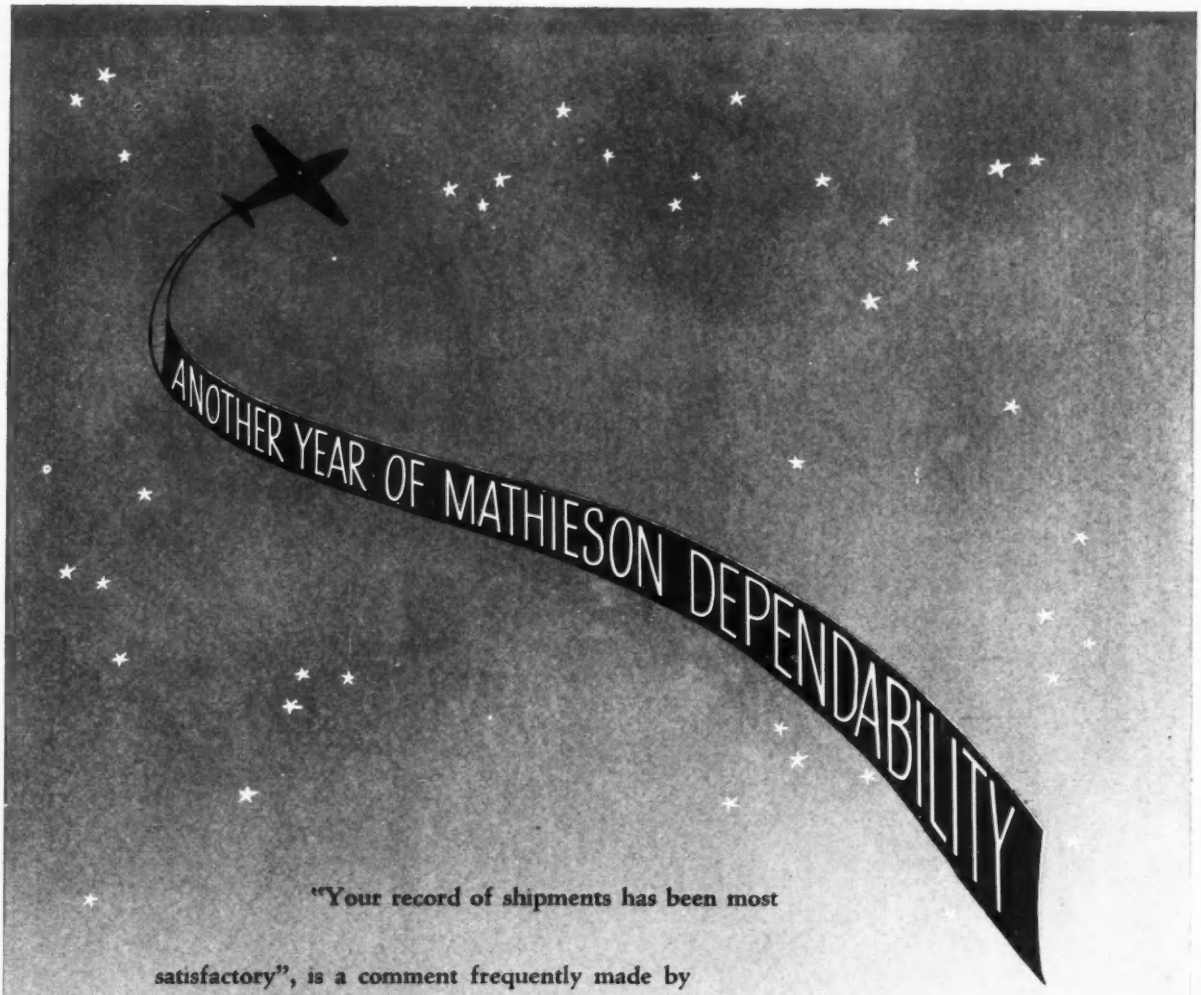

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